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PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

ACQUIRING AFFORDABLE WEAPONS SYSTEMS

STUDY PROJECT REPORT
PMC 77-1

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ACQUIRING AFFORDABLE WEAPONS SYSTEMS

Individual Study Program

Study Project Report

Prepared as a Formal Report

Defense Systems Management College

Program Management Course

Class 77-1

by

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE: ACQUIRING AFFORDABLE WEAPONS SYSTEMS

STUDY PROJECT GOALS:

To identify and evaluate DOD policies to obtain more affordable weapons systems. Also to become familiar with and evaluate models for O&S cost prediction and how O&S cost data is collected from the field and used to update these models. Lastly to determine how O&S cost considerations are influencing new system acquisitions.

STUDY REPORT ABSTRACT:

This project attempts to examine the approaches being taken to reduce the O&S cost implications of systems being acquired, and to examine the potential effectiveness of these approaches. The project was conducted by interviewing key people within OSD and the Services currently participating in outyear cost management, by researching recent available literature on the subject, and by integrating the results into a capsule summary and evaluation of current activities.

A series of efforts are ongoing. New draft management directives have been prepared in OSD and the Services aimed at infusing affordability considerations more heavily throughout the acquisition process. O&S cost data banks are being constructed by the Services to provide weapon system and subsystem cost visibility. Innovative procurement procedures and affordability management techniques are being used successfully on some new system acquisitions.

Considerably more effort is required before more affordable weapons systems become reality. This includes integration and increasing responsiveness of diverse organizational units, improvements in cost estimation, building of a suitably detailed cost data base, joint consideration of logistics support, manpower planning with design variables, and development of a more rigorous affordability discipline.

A reader of this report should be able to discover the scope and relationship among DOD activities in the area, and problems and successes that are being experienced.

SUBJECT DESCRIPTORS: Afford, Cost Models, Cost Estimates, Life Cycle Cost, VAMOSC, Operating Costs, System Acquisition, Logistics Planning, Management Techniques, Program Management, R-A-M, Support Concepts, Manpower Requirements, Maintenance Support.

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EXECUTIVE SUMMARY

The costs of operating and supporting our defense systems have grown rapidly in recent years. If the trend continues, we will be unable to afford the level of new defense system capability needed to match a changing threat. It is essential therefore to assure adequate consideration of operating and support (O&S) costs in the design of our new weapons systems.

This report presents a snapshot and discussion of the activities underway within DOD toward acquiring more affordable weapons systems. It should be of interest to individuals and organizations concerned with the funding, developing, and utilization of defense materiel.

To meet the challenge of affordability, both OSD and the Military Services have recently formulated initiatives, in draft form, to guarantee application of affordability management techniques throughout the weapons system acquisition process. These management directives provide that outyears cost considerations be an equal factor to technical performance, schedule, and development and acquisition costs in influencing system design. They direct that logistics support and operational usage be traded off along with design parameters in obtaining the most affordable and supportable configuration. More integrated involvement of logistics and manpower planners is proposed in the design and planning/policy aspects of system development and operational deployment.

Successful application of affordability management techniques is limited by current weaknesses in our ability to predict outyears defense systems costs to use for design and planning guidance. First, few if any cost models are adequate for this purpose. Second, very little operating and support cost data to use as a basis for cost estimating has been collected from the field at the weapon system and component levels.

To overcome this critical deficiency, the Services, under OSD guidance, are implementing procedures to provide an O&S cost data base by weapon system and subsystem. The Air Force and Navy are now able to collect aircraft system O&S data at the weapon system (model/design/series) level, while the Navy has been able to provide a working system to collect costs at the subsystem and component level. Analysis of this data will soon enable, for the first time, cost estimating relationships to be established, realistic cost goals to be formulated, and system and support elements requiring design emphasis and improvements to be identified.

By combining a rigorous affordability management discipline with suitable procurement techniques, innovative approaches to obtaining affordable weapon systems, and maximizing cost savings opportunities, have been developed and applied to the Air Force's AMST and the Navy's OTH RPV systems programs. If the expected savings in outyear costs materialize, an affordability management structure with general application to defense system acquisition will have been established.

In conclusion, a foundation for acquiring more affordable weapons system is beginning to be laid. Much hard work remains to complete the efforts recently initiated and assure their successful application. As never before, coordinated efforts and sufficient flexibility are required from diverse organizations, including the system developers, users, support organizations, and manpower planners, to be certain that all cost savings opportunities are provided in system and support design and are subsequently exploited when the weapons system becomes deployed and operating in the field. The O&S cost data base being established must be assessed for its adequacy to properly influence both system design and cost goal setting, and the technology of outyears cost estimation requires significant attention and growth.

ACKNOWLEDGMENTS

The author is pleased to acknowledge the considerable assistance and cooperation provided by many persons involved with improving system affordability. A special debt of gratitude is owed to Mr. Robert Houts of NAVAIR who spent many long hours assisting and guiding the author in obtaining a much broader and deeper understanding of O&S cost issues and approaches. The several sessions held with Lt Col Paul Clanton in the Air Staff (I&L) and Ms. Vivian Swinson of the Air Force's Comptroller organization were extremely helpful and useful. The comments and suggestions of Mr. Al Frager of what used to be ASD(I&L) helped raise the quality of the final product significantly.

Thanks must be given to my project advisor, Mr. John Mathias, who helped orient the project and make the initial contacts, and who willingly participated in progress reviews and preparation of the final report. Appreciation is extended also to Captain Thomas May for his willing assistance via long distance, and to "second readers" Dr. Ben Rush and Joe Arcieri, who along with everybody above, were subjected to reading my lengthy and arduous first draft.

But special consideration must go to my wife, Laurice, who not only volunteered to type that long initial draft on my less than adequate Webster portable typewriter, but who had to live with me (mostly without me) while I spent the time and effort in its preparation.

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SECTION I

INTRODUCTION

The costs to operate and support our inventory of defense systems have grown rapidly in recent years. As measured against the total defense budget, operating and support costs have increased from 20% to 30% whereas weapon system acquisition spending has declined from 30% to 20%.[4.B.2*] Since the defense budget is expected to maintain only a slow growth, this trend means that we will be able to acquire increasingly fewer new defense systems. Yet with a constantly changing threat, it is necessary to maintain a suitable balance between existing and newly developed defense capability. It is therefore necessary to be increasingly responsive, during the design phases, to the operating and support cost requirements that new systems will impose once they become deployed.

This paper discusses management procedures and related efforts for obtaining affordable defense systems; namely ones for which all aspects of system cost, including O&S costs over the expected system lifetime, have been adequately considered and minimized in the design and development process. In some cases, a greater emphasis on O&S costs during system development may result in somewhat increased development, acquisition and/or production costs. This can occur, for example, when higher quality and more expensive parts are used in the system to reduce downstream repair

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*The superscripts indicate the source of the information. In this case, 4.B.2 refers to the second reference under Section IV, Subsection B, in the List of References.

and replacement costs. A willingness of the Department of Defense and Congress to accept some front end cost increases in order to achieve suitable downstream cost decreases may be necessary in some instances to achieve system affordability objectives. The "softness" of future year cost estimates and the uncertainties in system usage and desirability imposed by changes in the threat must of course be considered when weighing design and system alternatives.

In order to consistently acquire affordable defense systems, it is necessary that O&S costs be required to be a significant factor in weapon system management and design. This has not generally been the case in the past. Initiatives undertaken by the Office of the Secretary of Defense (OSD) and within the Services (Air Force, Navy, and Army) attempt to ensure greater management emphasis in this area. Section II of this report discusses these new developments in affordability management.

Successful implementation of affordability management requires that suitable tools and techniques be available. Particularly important is the ability to obtain sufficiently reliable estimates of O&S costs. These estimates are needed to select among system alternatives and to choose design and logistics support approaches and parameter values in design trade offs. As of today, models used for O&S cost and life cycle cost (LCC) predictions are unable to provide realistic cost estimates. Since very little data has existed on O&S costs actually experienced by given weapons systems in the field, the models have not been suitably updated and improved. Section III discusses modelling techniques and indicates current strengths and limitations.

The critical need for collecting and making visible O&S cost data from the field at the weapons system and component levels is being addressed by the Visibility and Management of Support Costs (VAMOSC) efforts within each Service. Such data will be used for O&S cost prediction, budgeting, and as an aid to system design, source selection, and assessment of cost realism. Section IV discusses the OSD requirement for VAMOSC, difficulties encountered in developing a working O&S cost data base system, and the current status of the various VAMOSC projects.

In order to develop affordable weapon systems, procurement strategies and techniques must be utilized which motivate the contractor toward low-cost designs. Section V indicates various procurement alternatives, and discusses the innovative procurement and affordability management strategies being used with the Air Force's AMST and the Navy's OTH-RPV programs.

The new emphasis on affordability affects the contractors' organizations and way of doing business. A brief look at the impact the new directive may have on the contractor is the subject of Section VI. Section VII presents the author's conclusions and recommendations.

In summary, this report deals with a sampling of the current activity related to obtaining affordable systems. One goal is to present in a single document an integrated snapshot of what is happening today in the defense community in this area. Many of the documents, procedures, and material discussed herein are in the draft stage or otherwise incomplete or not yet approved officially. This area is so fluid, and moving so rapidly, that waiting for resolution of each of these items would result

in an untimely consideration of the key topics of this paper. To enable readers to obtain versions of draft documents updated to the time of their request, the bibliography indicates the prime author.

SECTION II

INITIATIVES FOR INFUSING AFFORDABILITY MANAGEMENT INTO SYSTEM ACQUISITION

Recent Historical Background

The milestone document which formally instituted system cost as a co-equal with technical performance and schedule is the Deputy Secretary of Defense Memorandum of 18 June 1973.[2.A.1] For major systems, a "Design to Cost" estimate was to be established no later than entry into Full Scale System Development. No discussion of O&S cost was included, however.

An earlier document, DOD Directive 5000.1, "Acquisition of Major Defense Systems," 13 July 1971,[2.A.5] included direction that system cost, including life cycle cost, be a significant factor in trade off decisions. However, this document did not have the impact of the 1973 memorandum. The revisions of DODD 5000.1 in 1975 retained the significance of life cycle costs as a critical management parameter.

The principles of design to cost (DTC) were expanded and collected into DODD 5000.28, "Design to Cost," dated 23 May 1975.[2.A.2] This document extended cost management into the life cycle cost (LCC) arena. Because of the recognized limitations in estimating O&S costs, however, O&S cost factors (or cost drivers), rather than O&S cost itself, are required to be identified for goal setting throughout the acquisition process. These include, for example, number of personnel, reliability and maintainability, etc., which clearly impact O&S costs and which can be quantitatively evaluated during test and evaluation and in the operational

phases. Unfortunately, without realistic cost estimation methodology, and without the ability to predict actual system operational requirements, the selecting of quantitative values for the cost factor goals is an inexact process.

This directive does require LCC estimates to be made and tracked however through the acquisition process, providing some measure of overall cost visibility, and some basis for tradeoffs or evaluation. While selection of the lowest technically satisfactory LCC alternative is stated to be the overall objective, O&S cost factor trade offs are constrained within the DTC threshold limits. When significant LCC savings can be achieved by violating the DTC threshold, the DSARC can be asked to consider appropriate DTC goal adjustment.

The Government Accounting Office (GAO) evaluated the effectiveness of the DTC management concept in its June 1975 report to Congress.[2.A.3] It indicated concern over the possibility that lower system acquisition costs may be obtained at the expense of higher O&S costs, and that tight controls on flyaway costs may significantly reduce system flexibility and growth potential, fostering a proliferation of weapons systems where previously one could have been sufficient. The GAO recognized that the 1971 version of DODD 5000.1 attempted to design weapon systems to LCC goals, but that inabilities to estimate these costs limited the effectiveness of this approach. The GAO appreciated the importance to credible O&S cost estimation of recent DOD VAMOSC efforts (discussed in Section IV) to collect an O&S cost data base for weapon systems currently in the inventory.

In 1976, the Deputy Secretary of Defense (DepSecDef) directed[2.A.6] that more effort be expended toward achieving affordable weapons systems. He requested that each Service establish O&S cost targets for each developmental system during the conceptual phase of system acquisition. Design decisions and tradeoffs were then to consider these O&S cost targets. Weapons system procurement decisions were directed to be influenced by the O&S cost requirements of the new system relative to the one being replaced. Another requirement in this document directed the Services to more critically examine and trade off the support concepts proposed for the new systems since they in themselves contribute significantly to O&S cost requirements. The importance of O&S costs relative to DTC goals was upgraded, and instructions were given to identify performance requirements that drive O&S costs and trade them during the DTC process.

Two additional requirements were placed on the Services, both important if the O&S cost reduction thrust was to be successful. First, new, more reliable, procedures for assessing the O&S cost impact of alternative systems were to be developed, and two, firm plans and procedures for translating potential manpower and resource savings for new designs into actual reduction of manpower billets and facilities with time were to be formulated by the Services.

The recent version of DODD 5000.2, "Major System Acquisition Process," dated 18 January 1977[2.A.7] further formalized affordability objectives. The costs of acquisition and ownership are required to be established as separate cost elements and translated into firm DTC and LCC requirements

for systems entering the full scale development phase. Both these parameters are now to be considered coequals with technical performance and schedule.

New OSD Affordability Management Direction

Early in 1977 a new draft DOD directive[2.B.1] was prepared in the Office of the Assistant Secretary of Defense for Installation and Logistics (OASD(I&L)). (In April 1977, the Material Acquisition portion of this office was shifted to the Office of the Director, Defense Research and Engineering.) This directive integrates and institutionalizes provisions of the earlier OSD cost management documents. It formalizes the O&S cost management process during system acquisition, establishes O&S cost management policies, and requires action aimed at increasing the realism of the O&S cost management.

One set of policies formalizes and strengthens the O&S cost management techniques in the DOD systems acquisition process. O&S cost estimates and O&S cost goals, which are specific valued parameters such as those in DODD 5000.28 that can be tracked and measured during test and evaluation and while deployed, are to be established early, updated, and suitably verified during the system acquisition process. Beginning in the conceptual phase, both system design and logistics alternatives are to be evaluated and developed through tradeoffs in terms of cost considerations, technical and readiness criteria, and logistics planning requirements. In relation to other system criteria, O&S cost is intended to be a measure of effectiveness that is one driver of management decisions.

Both development and operational testing programs are to be structured so as to provide relevant information for cost assessment.

In the procurement area, O&S cost and cost control visibility must be included in source selection, RFP's, proposals, contracts, etc.

A second set of policies is aimed at improvements in the important area of cost estimation. To develop and upgrade the O&S cost estimating capabilities within each Department, OSD encourages the Departments to establish cost estimating research programs. Cost data base systems using existing accounting systems are to be developed and implemented within each Department for obtaining and reporting actual O&S costs of major operational defense systems with visibility at the system, subsystem, and component maintenance levels. These data bases are to be capable of providing data to indicate significant equipment design, mission characteristics, and support concept cost driver elements, and should be coordinated with the cost estimating research development efforts. Feedback procedures are to be developed so that accumulated O&S cost experience and data will be distributed to qualified users including program sponsors, designers, logistic managers, cost estimation areas, and contractors.

Implementation of these objectives and policies recognizes that responsibilities must be shared among areas beyond that of the developing agencies alone. Within OSD an integrated O&S cost management effort will be established involving ODDR&E, ODDP&E, CAIG, and OASD (MRA&L). This approach provides for visibility and coordination of cost goal setting, costing methodology, and logistic support and manpower tradeoffs to all agencies concerned with or impacted by the costing analysis

and/or the setting of policy. For example, assignment of responsibility is made to the OASD (MRA&L) to develop methodology that can realistically relate manpower and training requirements to system design and logistics characteristics and to have manpower requirements track more closely manpower predictions made through the resulting cost management process established in this directive. This promises to add more realism and responsiveness to the whole defense system management process.

Lastly to provide direction and visibility to the efforts within each Service, each Service is asked to designate an official responsible for assuring that these O&S cost principles are applied in the acquisition of defense systems.

A Revised Air Force Procedure for Affordability

Efforts are underway in the Services themselves to increase the influence of affordability considerations in the system acquisition process. This section summarizes a proposed revision of Air Force Regulation AFR 800-11, entitled, "Acquisition Management, Life Cycle Cost/Design to Cost Implementation,"[2.C.1] now being circulated for comment and review among the Air Staff and the major commands. The procedures apply to acquisition efforts exceeding $1 million of procurement funded expense.

The philosophy and procedures of this draft revision require the implementation of strengthened LCC and DTC management concepts during system acquisition. The provisions contained in the document embody the concepts of affordability management and control found in the various DOD directives and memoranda discussed earlier, including almost all of those in the draft DOD directive discussed in the previous subsection.

The affordability management objective is to consistently provide serious consideration of the combined acquisition and O&S cost effects of system decisions. This will be used to obtain design and system solutions which provide the most favorable LCC outcome consistent with constraints on technical performance and operational requirements. While a minimum LCC result is aimed at generally, the regulation recognizes that in some cases a different balance between cost and effectiveness may be preferred. Use of the DTC concept is treated as an integral part of the cost management effort and goals will be required for unit production costs, logistics support resources, and O&S cost factors (or drivers) including manpower requirements, operational reliability, and maintainability. One novel feature is the use of LCC estimates to set DTC goals, permitting a selection of flyaway costs consistent with minimal LCC solutions. In some cases, this could result in a higher flyaway cost than would exist without the constraints on LCC.

The control of system costs, both in terms of acquisition and O&S costs, is to be achieved through trade studies involving operational capability, performance, cost, and schedule. Operational and support concepts, in addition to design parameters, will be subject to this methodology. Cost analyses will be conducted to the level where there are meaningful distinctions between alternatives.

Affordability considerations are to be used in tailoring procurement strategies, and play an appropriate role in evaluating competing proposals. When used in this way during source selection, the RFP must inform contractors of this intent, indicate how the evaluation is to be made, list the inputs needed to perform the evaluation, and provide the specific

cost element structure to be used by the government. It is recommended that the weight given to LCC in source selection reflect the extent to which meaningful distinctions between competing proposals can be made and the ability of the evaluators to determine the LCC merit of the alternatives.

Procedures are included for improvements in the cost estimation area. In terms of general O&S cost prediction, Air Force Systems Command is given the responsibility for providing improved cost estimating relationships and cost factors, and the Air Force Logistics Command is requested to provide an O&S cost data bank on deployed systems. To improve the quality of system cost estimates, the joint participation of the implementing, using, and support commands, under the direction of the implementing command, will be required. In terms of updating and verifying the O&S cost estimates during the acquisition process, the OT&E agency is required to conduct a general evaluation of the LCC estimates and report the results to help in updating the estimate and, where necessary, cause changes to the system itself. After initial deployment, O&S cost validity is to be assessed prior to introducing significant quantities into inventory, and continued post deployment analyses are to be conducted to subsequently further improve O&S cost characteristics.

An important caveat appears in the draft document. It recognizes that the specified practices exceed current capabilities and experience to implement them, so a moratorium of one year is suggested to allow development of the needed machinery and tools.

In this author's opinion, the OT&E agency will need significant guidance in being able to assess O&S cost estimates during testing, and it might be better to provide them with a list of cost drivers, have them measure those as well as providing feedback on other items they believe significant, and have the implementing agency use this data itself to update the cost estimate. Also, possible delays in introducing the system into inventory will have to be balanced with any requirement for assessing O&S costs after limited initial deployment.

SECTION III

PREDICTING O&S COSTS THROUGH MODELLING

In designing for affordability, one must compare the cost impact of alternative design elements. To do this, a means of predicting cost, such as O&S cost, must exist. The "means" for cost estimating are cost models.

Models providing sufficiently valid and timely results are essential to achieving affordable systems. If no model exists to estimate costs, or if the model results lead the designer to incorrect conclusions, application of affordability discipline techniques will largely be for naught. In this case, O&S cost factors would have to be used again rather than O&S cost itself.

Currently, O&S cost estimation is the weakest link in designing for affordability. In this section, types of cost estimation models available for use are discussed and evaluated. Overcoming the significant weaknesses that exist in this area will require considerable effort and time, and involve the participation of the diverse organizational elements concerned with weapon system development, deployment, and maintenance. Particularly critical to improvements in this area is the development of a real world O&S cost data base to use for model development and evaluation.

The reader is referred to references 3.1, 3.2 and 3.5 for modelling details in greater depth than that discussed in this section.

LCC or O&S cost models serve several functions. They provide estimates of O&S costs which are used to support weapon systems management decisions, such as DSARC reviews, to support budget planning

estimates, and as an element in source selection. Their results are or will be utilized in cost goal setting at each decision milestone, in contractual commitments and incentives. In addition, they are used in trade studies to help select among alternative system configuration and equipment designs.

For LCC or O&S cost models to satisfactorily perform these functions, they must possess some primary characteristics. First, the model must be valid for the application to which it is being used. Validation is a critical requirement for model application, and the best validation occurs when real world results can consistently be predicted within reasonable bounds. Second, the model must be sensitive to the design or structural parameters being considered and compared. When comparing two subsystem alternatives, a LCC model which considers only system level design parameters is most often inadequate. Third, the input data requirements must be such that reliable information is available for use. In many cases, data required for input is either not available when needed or is of questionable validity. Fourth, the model must be complete, but as simple as possible. These requirements are complementary not contradictory. The model must account for all factors affecting the elements of cost appropriate to the problem being analyzed, but the model, prior to intensive use, should be simplified to delete explicit dependence on parameters to which the results are insensitive. Fifth, the model should be fully and clearly documented so that users can assess its suitability and make changes as necessary.

Four categories of LCC or O&S models have been used extensively. Parametric models, which include cost factor models and cost estimating relationship (CER) models, utilize derived equations (usually obtained through regression analysis on similar systems or from experience in the field) to relate elements of O&S cost to weapon system design, performance, and support. Accounting models use a set of equations to aggregate components of O&S costs, such as material, manpower, and support, into a single LCC or O&S cost value. Each individual cost component is obtained by considering the relationship of factors involved in performing the function involved (e.g., depot maintenance cost elements). Simulation models attempt to recreate on the computer the actual operational situation, support concept, design and cost factors, manning levels, etc., to potentially provide a set of statistics on any of the issues being modelled, e.g., mean cost and average level of manpower needed to achieve a certain effectiveness, etc. Optimization and analysis models are those which consider a small set of O&S cost issues and establish a relationship between costs and the parameters involved, or optimize the design of the facet of the system under consideration, with other system and environmental factors considered as given inputs. Optimum repair level analysis, minimum cost spares list optimization, and inventory management optimization are typical examples of models in this category.

Several examples of these model categories will be discussed. Air Force models are used for illustration; however, intensive modelling work has also been performed by the Navy (NAVMAT; F-18 LCC models) and the Army (LSA model developed by Blue Ridge Depot in Lexington, KY).

The Air Force's Logistic Support Cost (LSC) model, whose equations are given in reference 3.4, has had extensive application to many aircraft weapons systems, most recently to the F-16 in terms of incentive awards, and to other programs in terms of influencing source selection as well as design tradeoffs. This accounting model aggregates ten components of logistic support costs, each calculated itself by a simple summation of subcost elements. The ten factors are the cost of initial and replenishment spares at the line replaceable unit (LRU) level, on-equipment maintenance, off-equipment maintenance, inventory management, support equipment, personnel training and training equipment, management and technical data, facilities, fuel consumption and spare engines. Operating scenario, reliability and maintainability parameters, and labor costs are used directly in these equations. When used by competing contractors, the tailored LSC model for the system under consideration is provided to each contractor along with values for government supplied model standards and constants; e.g., labor rates, flying hours, etc. Each contractor then supplies his estimates of input parameters, with a justification, in order to arrive at his estimate of logistic support cost. Subsequent verification by testing of input elements is planned for, where desirable, possible, and/or necessary.

An important Air Force model using parametric inputs is the Cost Analysis Cost Estimating (CACE) model which is used to support O&S cost estimates for submission to the DSARC. This top level accounting model considers only weapon system level cost parameters and typically estimates O&S costs by using cost factors to determine cost elements such as spares, support equipment, manpower and munitions. Estimates of each of

these cost elements are generated by multiplying a factor derived as a function of Air Force cost experience on similar weapon systems by key parameters of the new weapon system program such as number of flying hours, number of weapons to be purchased, or flyaway cost.[3.1] No CER models are available in the Air Force to predict overall O&S costs.[3.1,3.5]

The Air Force's Maintenance Manpower Prediction Model, whose primary component is the Logistic Composite Model (LCOM) developed jointly by RAND Corp. and AFLC, is an Air Force validated simulation model for estimating maintenance manpower requirements for a new weapons system and for evaluating design tradeoffs in terms of manpower requirement impact. It has the potential to be used to evaluate support concept, design, and cost tradeoffs. This model simulates prescribed operational scenarios, and incorporates proposed aircraft scheduling, manpower policies, and support concepts, and includes as input relevant system design features such as failure rates, maintenance parameters, and available resources. The output includes detailed information on the level of operation achieved during the simulation and on the corresponding use and expenditure of resources, and includes personnel manning requirements by work center to meet "on aircraft" demands for maintenance. This model has been used on the A-10, A-7, F-16, and AWACS programs.

A plethora of analysis and optimization models exist for treating the many specialized or limited considerations for which an overall system cost model is not considered cost effective. The reader is referred to 3.1 and 3.5 to obtain more detail.

A comparison of these model categories shows that, as of today, no combination of them can be used to reliably estimate O&S or LCC costs for a weapon system under development. The parametric models have the advantages of being easy to use and inexpensive to apply. They include a comprehensive cost base; namely that "total" real world costs are utilized rather than just those predicted to be involved by the system designer or cost estimator (i.e., all weapon system related costs are accumulated by the Service's accounting systems, not only demand costs for when an item needs repair). These models are most appropriate for application during the conceptual or early validation phases of system acquisition when little system design detail has been developed.

The disadvantages of these parametric models include first and foremost the current unavailability of CERs relating design performance to overall O&S costs or even many of its cost components.[3.1,3.5] This contrasts strongly to the large variety of CER models (e.g., RCA's PRICE model) which can be used to estimate development and/or production cost for a weapon system. Further the parametric models are not sensitive to many system, and subsystem design parameters, precluding effective use for system design tradeoffs and in acquisition phases such as late validation, full scale development (FSD), and production. These models do not apply to new technologies or designs where previous cost histories are either not available or applicable. In addition, the costs used to generate the parametric relationship often include the influence of uncontrolled variables. This sometimes results in uncertainties as to what actually is driving the parametric trends.

Accounting models have the advantages of considering system design parameters to the subsystem and component levels (at least in terms of

reliability, maintainability, item cost, manpower requirements, etc.) and considering support concept elements. They often reflect the interrelationships among cost drivers, system operations, and system usage and support. These models are most suited for application in the validation and FSD phases, and their costs to use are most often quite moderate.

There are several disadvantages of accounting models. Many real world yet significant cost influences are unmodelled either because they are unknown or because no suitably realistic models have been developed. For example, realized operational availability, maintenance actions, and manpower support and overhead are inferior to the design parameters inserted in the models. Even if they did match, the actual statistical behavior of these items (e.g., failure rates) differ significantly from the assumptions used in the model. Additionally, these models currently assume incorrectly that all savings possible due to the improved reliability or reduced maintenance requirements inherent in an alternative design would be translated into equivalent savings in the field. In many cases also, we cannot be certain that all costs are being taken into account. The models cannot be used easily in the conceptual and early validation phases where little data exists on how to convert overall mission objectives into suitably quantitative design requirements and parameter values. Lastly, and quite significantly these accounting models have not been validated by comparison with real world O&S cost data, and it's difficult to link accounting model totals to either reported actuals or to parametric model outputs.

Simulation models will, in the author's opinion, be used increasingly in the coming years to examine several system design, support, and cost elements simultaneously. These models provide "dynamic" interrelationships among the environment, support concept, system usage, and system design, and are inherently capable of detailed modelling of all key cost contributors, once known. They can answer "what if" questions and provide for detailed tradeoffs. Unfortunately these models are expensive and time consuming to construct, costly to use, require extensive input information, and hence are most suitable for use (when considering new types of weapon systems) in the FSD phase, rather than the conceptual and validation phases where the greatest potential exists for cost reduction. They are complex and require intensive tailoring to remove insensitive variables. While so far, the orientation of these models has not been so much to O&S cost itself as to other cost factors (such as manpower requirements and support planning), there is no major difficulty in using them for this purpose.

Optimization and analysis models have an important role in structuring the parameters of any new weapon system. Generally any contractor or project office will employ several of them for use in defining and selecting different design elements. These models are quite manageable and provide a detailed representation of specific factors, considered essentially individually, which contribute to O&S costs. They provide a reliable and efficient means of optimizing or analyzing cost factors when the remainder of the problem is specified. Their disadvantages include first that they only look at a microcosm of the overall system design problem, and second that in a not insignificant number of cases,

optimization of the element being considered may not be consistent with optimization of the overall structure. In the latter case, changes to the "givens" have to be traded off along with the optimal result of these models to provide an overall best solution. Lastly these models must often be individually developed and tailored for each system under development.

Several of the essential O&S cost estimation model deficiencies must be corrected before their results can be used meaningfully and reliably. O&S costs from <u>deployed systems</u> at an appropriate level of weapon system and subsystem breakout must be obtained with satisfactory validity and in a useful format. They then must be analyzed and fed back to the cost estimating community. For example, from this data, needed CER's can be established for use in early phases of system acquisition. Feedback should also be used to validate and/or direct changes in the accounting models used in the validation and FSD phases. O&S cost data from the field can in some cases be used directly in the various models. Since the input data requirements of the models and the forms of data provided by the cost accounting systems differ, means must be developed to provide the appropriate degree of compatibility.

Some crucial assumptions used in the accounting models and others must be replaced by more realistic representations of the real world.[3.15] Considerations of reliability, for example, assume random failures only, and make no provision for the implications of corrosion, fatigue, and wearout.[3.14] Design values are used rather than failure rates, apparent or otherwise, that actually are incurred in the field. Secondary failures, "irrelevant" failures due to extrinsic causes which may be ignored in

specifications but keep the maintenance personnel occupied, are ignored, as well as the problem of incorrect part replacements, false fault alerts, and intermittents. Similar comments apply to the maintainability related modelling incorporated into the accounting models.

Particularly critical is the models' assumption that improvements in reliability, maintainability, and some elements of manning, translate directly into corresponding manpower savings. Unless manpower billets and assignments are restructured by the Services to match the actual (not predicted based upon the above assumptions) reductions anticipated for a new weapon system, none or at least a small fraction of this savings will be translated into manpower cost reductions.[5.A.1] And, this may not even be possible, even if a serious attempt was made to do it, in some applications such as ship systems, where peak manpower intensive requirements for critical functions such as damage control, draw upon assumed levels of manpower pools for other functions, and where manual backup procedures must supplant automated operations when equipment casualties or breakdowns occur.[3.13]

Related to this discussion, and to the setting of O&S cost "factors" goals in the acquisition process, is the belief that the selection of support concept currently impacts O&S costs at least as much as reliability/maintainability (R/M), and that significant effort needs to be undertaken to jointly optimize the relationship and design of the R/M and support concept elements.[5.A.1,3.15] Further examination is needed to determine real O&S cost benefits achieved vs. R/M improvements and to learn how to specify contractual R/M requirements such that a translation to real world R/M results can be made.

SECTION IV

ESTABLISHING AN O&S COST DATA BASE FOR IMPROVED COST ESTIMATION AND DESIGN DECISIONS

OSD Requirements to Provide Visibility of O&S Costs

To get a handle on the O&S cost and resource problems, and encouraged by Congressional interest and questioning, OSD recognized the need to accumulate costs incurred operationally by weapon system and at the subsystem and component level within each weapon system. Such an accumulated data base would aid in developing needed cost estimating relationships and models, in making design tradeoffs during the acquisition phases, in assessing the reasonableness of O&S cost predictions for new weapons systems similar in many respects to those in the inventory, in developing and evaluating logistic support alternatives, and in using these results in making new weapons acquisition decisions. Further this data could be used to project more reliably the O&S cost and management requirements of existing systems, make tradeoffs between new system acquisitions and maintenance of current inventory, and identify elements or subsystems of weapon systems which are imposing an unreasonable share of O&S cost resources. These considerations were the basis of OSD Management by Objective (MBO) 3-12[4.A.1] in FY 75 and its successor MBO 9-2[4.A.2] in FY 76. Both are titled Visibility and Management of Support Costs (VAMOSC).

MBO 9-2 has as its objective the development and implementation of a cost effective system to identify operations and maintenance costs by weapon system and subsystem. Its necessity arises from the condition that defense cost accounting systems do not accumulate costs by weapon

system; instead they accumulate them by function (e.g., training, depot operations, maintenance, etc.). In addition current DOD management requirements on accounting data relate to the type of organization accumulating the data rather than to the weapons systems the organization supports. Whatever attempts had been made to relate O&S costs to weapon systems had to be performed on the basis of some allocation scheme. Also the various accounting systems within each Service were unique and distinct, and could not easily be integrated together.

The direction contained in MBO 9-2 was to have each Department (Air Force, Navy, Army) define its own peculiar cost information system (CIS) providing it with a long term historical weapon system cost perspective. The first major milestone was to develop this CIS to identify O&S costs to the weapon system level (e.g., model/design/series (M/D/S) equipments, such as the F-4E aircraft, the DLG ship, etc.) The first step within this milestone was to develop the cost data system to handle aircraft, since each of the three Services utilize aircraft weapon systems. Following that, a CIS was to be developed for other more Department peculiar weapons classes such as missiles, ships, etc. The second major milestone was to develop an expanded CIS to provide maintenance cost data (such as labor, material, support) at the subsystem (e.g., fire control system, radar, transmit/receive unit, etc.) and replaceable component level, with work unit code (WUC) detail. The last major milestone involved standardization of the data systems across the Services and OSD (e.g., CAIG).

Existing accounting systems were to be used to the extent possible, although requirements for changes and resulting costs were to be identified,

and the final CIS was to be computer based although inputs to the system could either be manually generated or provided on automatic data processing (ADP) elements. The resulting systems were to be exercised and evaluated as to their utility by having them provide results for several fiscal years (FY 74, 75, 76) of weapon system operation, and having the results analyzed for usefulness, completeness, and time of availability.

The basic steps employed in implementing the VAMOSC requirements were to be[4.A.3] to identify the weapons systems on which data would be collected, identify the cost elements to compose the O&S costs of each family of weapon system, break down each system using WUC designations into units representing major O&S cost drivers, define each cost element and WUC breakout in detail, identify data to be provided directly from accounting systems in use today and data to be constructed through sampling or allocation, construct specifications on the Cost Visibility CIS (including cost element definitions, data sources, data formats, data processing requirements, etc.) to be constructed to provide the desired cost informat..n, implement the specified system, exercise the system on one or more fiscal years data, and evaluate it relative to its meeting specified VAMOSC objectives, its general utility, and its cost.

The Air Force and the Navy have made significant progress, having already produced CIS systems which have provided the requisite support cost data at the weapon system (M/D/S) level. Both Services have efforts underway to obtain data on other weapons classes (ships for the Navy, missiles for the Air Force) and on maintenance costs at the subsystem level with WUC detail.

The Army, however, has had difficulty making headway in its VAMOSC program (which it calls O&SCMIS). The Army accounting systems must deal with large numbers of small units, adding a degree of complexity beyond that experienced by the Air Force and Navy. The O&SCMIS effort is currently in the requirements stages, and references 4.A.4 through 4.A.7 summarize the latest Army direction in these areas.

The Air Force VAMOSC Program

1. O&S Cost Visibility at the Weapon System Level

After the VAMOSC MBO was released in early 1974, the Air Force was directed in June 1974 to develop a pilot Cost Information System (CIS) to provide aircraft system O&S costs at the system (Mission/Design/Series - M/D/S) level, and to provide a data report showing these costs using Fiscal Year 1974 cost data. Reliance on existing data sources was stressed, and creation of new cost accounting systems was to be avoided.

This project was directed by the Assistant Secretaries of the Air Force for Installation and Logistics (I&L) and Financial Management (FM). An Air Force Working Group, consisting of broad AF functional area representation, was created to develop and implement the O&S cost data system.

The Air Force team adopted a three phase, stepped approach toward achieving the VAMOSC system level O&S cost reporting objectives.

Phase I was a feasibility and validation phase in which CIS structure was defined, problems were identified and solved to at least some extent, and data sources were analyzed and integrated. A manual O&S cost report

was developed to provide FY 74 O&S costs for four aircraft systems -- the C-141, C-5A, F-4E, and KC-135. In February 1975, this FY 74 O&S data report, with accompanying documentation, was delivered to OSD.

Phase II, initiated in April 1975, involved automating the system for which Phase I served as pilot, and expanding it to handle all active AF aircraft forces. The resulting mechanized O&S cost CIS, named the Operating and Support Cost Reporting (OSCR) system (and subsequently renamed the Operating and Support Cost Estimating Reference (OSCER) system), was developed, checked out, exercised, and completed by January 1976. This included revision of cost data allocation algorithms from Phase I, expansion of the OSCER input data base to include over a dozen major existing CIS for the FY 75 period, and creation of all computer programs including data extraction routines.

The OSCER system was the first mechanized capability in DOD for providing annual O&S cost summaries at a weapons system level. Appendix A, taken from reference 4.B.4, lists the cost account categories presented by OSCER.

Phase III represents the continuing efforts to improve and upgrade OSCER. Begun in the summer of 1976, the work here includes final editing of documentation to provide an audit trail as data sources, OSCER methodology, and specified cost accounting systems change with time. Also prior to April 1977, OSCER was converted to be directly relatable to the new (1976) CAIG Aircraft Operating and Support Cost Element Structure, as listed in Appendix C of reference 4.B.4. Other Phase III efforts involve establishing procedures for assuring that data collection will be continued on a regular basis, developing improved techniques for cost

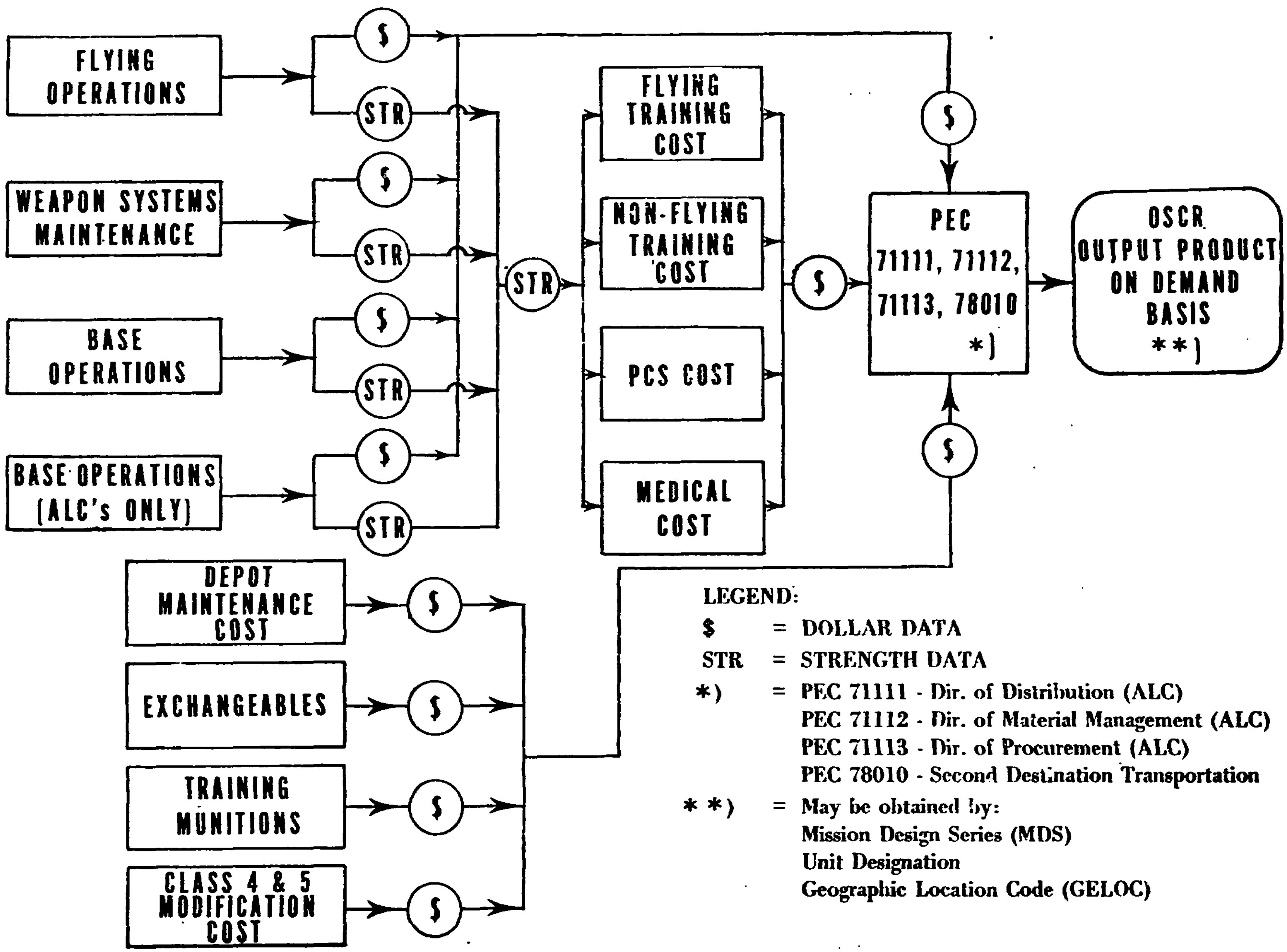
determination and/or allocation to be used within OSCER, and development of tactical and strategic missile cost models.

The OSCER system operates by taking strength (manpower, material) data and cost data from the various data sources, combining and accumulating them, and allocating cost items by M/D/S. Figure 1, taken from reference 4.B.1, provides an idea as to the working structure of OSCER.

Many difficulties were encountered in developing the OSCER system, some of which still have not been completely overcome. These difficulties can be categorized into several areas. The first includes availability, completeness, accuracy, and trackability of the data itself. The second is the means used to assign cost data collected at various levels to a given MDS. The third is use of planning factors for accumulating costs, rather than actual costs. A fourth category is inherent inability to attribute costs accurately to specific air bases.[4.B.3]

Severe problems existed with the potential data sources. Much desired data was not available. Even if it had been available at one time, it often was subsequently lost since few requirements existed that data be retained over one year. Even when data was retained, the data was often unuseable because lack of an audit trail made it impossible to overcome problems with year-to-year consistency, relevancy, and frequent computer system changes at the source points. Some data, even if available and interpretable, was either incomplete, inaccurate or both. Often times maintenance forms hadn't been filled out because of higher priority tasks or lack of concern for this aspect of the job or else weren't filled out accurately. Some forms require so much information that the maintainer, at the end of the day, is unlikely to provide the quality of

FIGURE 1. OSCER SYSTEM DESIGN SCHEMATIC



LEGEND:

$ = DOLLAR DATA

STR = STRENGTH DATA

*) = PEC 71111 - Dir. of Distribution (ALC)
PEC 71112 - Dir. of Material Management (ALC)
PEC 71113 - Dir. of Procurement (ALC)
PEC 78010 - Second Destination Transportation

* *) = May be obtained by:
Mission Design Series (MDS)
Unit Designation
Geographic Location Code (GELOC)

information desired. In other cases, the information desired is not currently included in the data recording system. Lastly, between data systems, a single item may be categorized differently (e.g., F-4C vs F004C vs F/4C), given different code numbers even within standard categories and accumulated differently (e.g., being in the 2300 category at one Responsibility Center/Cost Center (RC/CC) and 2310 elsewhere).

The data and accounting systems used as source data inputs to OSCER generally do not collect or provide cost at the MDS level. Consequently assignment or allocation algorithms are necessary in order to determine how much accumulated cost to attribute to each of the MDS types contributing to that cost. This is generally recognized to be one of the biggest weaknesses of any approach such as OSCER, especially when reliable or available data does not exist to form a sound basis for the allocation process. Often the allocation process hides real differences. Within OSCER, it is necessary to perform extensive allocation. The bases used for allocation depend on the cost parameter involved, and can include aircraft flying hours (FH), direct labor hours (DLH), aircrew strength, aircraft inventory, maintenance force strength, etc. Base maintenance costs, for example, are not reported by organizational unit or M/D/S. As a result, distribution of direct labor hours is used to allocate the overall costs in this category. Indirect labor hours are also assumed distributed proportionally to recorded direct labor hours. Similarly, weapon systems maintenance costs, computed separately by RC/CC, are allocated to squadrons on the basis of worldwide cost per flying hour factors developed from direct labor hour information for each type of maintenance category.

The use of cost standards, rather than actual costs, as the basis of cost accumulation is another potential key contribution to the weakness of OSCER allocation methodology. In aircraft depot maintenance for example, costs for GFM and contract items reflect projected unit repair costs estimated by an industrial specialist, rather than actual costs. Fuel consumption costs use fuel consumption per flying hour factors based upon historical fuel usage rates, and bulk fuel price rate averages. The use of cost factors in weapon system maintenance costs was mentioned in the previous paragraph. Related to cost factors is the methodology used for replenishment spares costs at the depot level. An average percentage of the depot unscheduled maintenance cost, at a WBS level, to the inventory value of Not Reparable This Station (NRTS) items is calculated, as well as the average percentage of reparable spares to total spares returned for repairs and these numbers together with overall depot maintenance unscheduled repair costs, are used to estimate the cost of replenishment spares.

Accurate allocation of costs to the airbase level is also quite difficult. When visiting aircraft are stationed TDY at a base, costs associated with their support are generally recorded as an inseparable part of the support costs for the directly assigned aircraft. Their pay and allowances, however, may be reported by their home base. Sufficient instances of these kinds of problems occur, due to extensive aircraft rotation, that use of worldwide averages for M/D/S cost accumulation rather than base level cost assignments was deemed desirable. To the degree that base level cost comparisons are desired, reporting system changes will have to be introduced.

Three other items affect the statistical confidence of the OSCER results.[4.B.4] One is that certain cost elements such as weapon system security are not included. Second, inventory level changes lag the activity which caused the change, yet inventory level itself is the basis of cost allocation to M/D/S. Third, inconsistencies exist between allocating of manpower tc a base according to wartime requirements, but accumulating O&S costs based on peacetime expenditures. Logistics Management Institute (LMI) suggests that the relative resource utilization by M/D/S may change drastically upon wartime conditions, that the figures thus being derived based on an OSCER peacetime allocation are misleading, and that an allocation procedure reflecting these considerations should be derived.

The degree to which any of these problems need correction depends on whether or not management decisions to be made using this data would be changed by such improvements, and the cost of the improvements relative to the benefit of the improved decisions. The adequacy of the current Phase III OSCER upgrading efforts should be assessed in that light. The primary users in the DSARC process, cost analysis areas, and force projection organizations should address these issues jointly.

The development of OSCER by the Air Force was a major step forward in the O&S area. In its current form, OSCER can provide results sufficient for getting a handle on O&S costs by M/D/S and to indicate cost trends. Data for FY 75 has been provided, and the FY 76 data reports are expected imminently. OSCER results have already been made available to contractors, including Boeing and Grumman, to help in their efforts

to reduce the O&S cost implications of the aircraft systems they design. Appendix B shows a sample, for FY 75, of the top level data that OSCER provides.

The OSCER effort has brought together productively the logistics, manpower, and accounting organizations within the Air Force. The data collected by OSCER will be used as a basis for upgrading AF Regulation 173-10 which provides guidelines for "gross" cost estimating.[4.B.3]

As mentioned heretofore, the missile weapon system effort (a subset of Phase III) has been initiated by the Air Force to provide O&S cost reporting at the systems level for both tactical missiles (TM) and strategic missiles (SM). For the OSCER/TM, data reports are due by the end of this year, while for OSCER/SM, results are scheduled for June 1978. Intermediate milestones for the cost model and the allocation methodology are planned.

2. Maintenance Cost Visibility at the Subsystem/Component Level

To get visibility of maintenance costs at the subsystem and component level, to the 3rd - 5th level of work unit code (WUC), a CIS separate from OSCER was required. A distinct Air Force project is being undertaken[4.B.6] to construct the required data system, termed informally the line replaceable unit/shop replaceable unit (LRU/SRU) project (LSP will be used in this report). The LSP results would provide the project offices and contractors a means to identify system elements where improvements are required, and would serve to provide data for conducting design tradeoffs, performing requirements allocation within the M/D/S indenture, improving detailed O&S cost estimating, and identifying

potential areas for contractual incentives and awards. The data would also be directly useable in projecting maintenance resource requirements more accurately and could aid in eliminating use of some maintenance related cost standards in OSCER.[4.B.3]

The Program Management Directive[4.B.5] for LSP was prepared in February 1977. AFLC is the implementing command for the Air Staff. System development will resemble that for OSCER, using a prototype design, manual collection, assembling, and evaluation of cost data, and application to a single aircraft system. The candidate prototype design(s) for estimating annual depot and base level logistics support costs at the LRU/SRU level are planned to be available for demonstration and evaluation at the end of August. Comprehensive implementation of a satisfactory solution is planned to take about one year. Later extension to missile systems is anticipated. A separate system is being implemented for communications, electronics, and meteorology systems.

The LSP constraints differ from those applied to OSCER. For LSP, data sources and procedures can be somewhat modified if found essential to do so in order to provide sufficient quality of LSP output data. LSP includes elements of logistic support costs only, and hence is not concerned with many of the OSCER cost elements such as operating crews, etc. Allocation of costs will be part of LSP where necessary, but where it cannot be done "sensibly," costs in question will be portrayed at the lowest reasonable aggregate level.[4.B.6]

LSP will try to use the Maintenance Data Collection System fairly extensively, and to interface with OSCER as necessary. It will also build on existing systems such as the K051 system, which supports AFLC's

Improved Reliability of Operational Systems (IROS) program and identifies the highest cost WUC items within a weapon system.

To increase the general utility of LSP, certain data enhancement features are planned. Data formats are to be selected after review with potential users. The cost data will be augmented with the operational concept being used with the item, usage activity, reliability and maintainability, and other performance and design information which can enhance the potential utility and application of the LSP data.

The Navy VAMOSC Program

The Navy response to MBO 3-12 took shape in late 1974, and involved intensive effort by Service participants and two outside contractors. Unlike the Air Force VAMOSC efforts which were conducted entirely in house, the leaner Navy organization relied on outside support, particularly Information Spectrum Inc. (ISI), for assistance. By January 1975 a series of VAMOSC related tasks were completed, and detailed VAMOSC system definition analyses and recommendations were documented in a final report, reference 4.C.1, which helps provide background for the following discussion.

The study addressed plans to achieve both VAMOSC MBO objectives: developing means to identify all O&S costs at the weapon system (M/D/S or Type/Model/Series (T/M/S) as used by the Navy) level, and also means to identify detailed maintenance costs at the subsystem and/or component level. The VAMOSC task sequence described earlier was followed, beginning with identification of cost categories contributing to aircraft system support costs, and concluding with a manual exercise simulating the data

extraction planned for the Navy near term VAMOSC CIS, using FY 74 data for the A-7E. Implementation and recurring maintenance costs of VAMOSC CIS alternatives were estimated.

Two separate systems were defined to meet the two objectives of the MBO, as applied to aircraft weapon systems. The first, Total Support System (TSS), identifies O&S costs by individual weapon system. The second, Maintenance Subsystem (MS), addresses direct maintenance costs in terms of labor and material against elements of the Work Breakdown Structure (WBS) by selected indenture of Work Unit Code (WUC) to get to the subsystem/component levels where possible.

Unlike the Air Force which had to start almost from scratch on its LRU/SRU program, the Navy had in prototype development a system called the Maintenance Cost Model (MCM) which, when operating with the Navy's Maintenance and Material Management (3-M) System, was able to provide much of the data required to provide visibility into weapon system maintenance by WBS for the organizational and intermediate levels.

The existence of the MCM and 3-M systems within the Navy, and the absence of any system to perform the TSS functions resulted in separation of the efforts used to develop TSS and MS. The TSS CIS definition and development effort was conducted by ISI under the direction of NAVAIR 4105, while the MS development was conducted entirely in house by the Navy.

The TSS system obtains aircraft weapons system (T/M/S) data using the operating squadron (or unit) as the focal point. The remaining costs related to T/M/S are the intermediate (base) and depot level maintenance of the aircraft, aircraft modification programs, training of

personnel for operation and maintenance, engineering services and support, and update of publications. Appendix C, taken from 4.C.1, indicates the top level cost breakdown provided by TSS. Personnel costs are identified in terms of military, civilian, and contractor personnel. The rework costs under the Depot Support heading (1.3) include direct civilian labor, purchased material, and overhead, and are further broken down by whether work was performed intra DOD or by commercial contractors. The component rework costs as well as the cost of replacing reparable spares (1.5.1) are collected on a National Stock Number (NSN) basis and then allocated to contributing T/M/S.

Costs for ground support equipment maintenance and replacement, and second destination transportation are not accumulated in TSS because no means of allocation could be determined which was not very arbitrary.

The MS system uses transaction accounting (as performed by the 3-M system) directly related to the T/M/S to obtain the resources consumed in the maintenance process. An appropriate cost valuation (through use of MCM) is then applied to the incurred expenses. Appendix D indicates the top level cost breakdown provided by MS.[4.C.1] At the squadron level, the resources utilized in maintaining an aircraft are broken down by the applicable WUC level, with direct labor costs allocated based on charges reported on 3-M Maintainance Action Forms. Maintenance actions are separately identifiable as to whether they are scheduled or unscheduled. The rework items under the Depot category (2.3) are detailed to the WUC level, and as for TSS, are broken down into direct labor, material, and overhead. Both scheduled and unscheduled component rework efforts are separately tabulated.

The integration effort necessary to obtain functioning VAMOSC CIS's involves use of twelve distinct accounting or data systems for TSS and at least four for MS. As experienced by the Air Force, all have different characteristics, quality of information, degree of automation, and update intervals. Since for the near term VAMOSC objectives, only the minimum necessary changes were to be made to these data systems, most of which were designed to meet alternate objectives, compromises and simplified procedures had to be developed.

A variety of difficulties with the accounting systems had to be overcome in generating a satisfacotry near term VAMOSC program. A key problem was that the 3-M MDCS system to be used for the MS did not include depot maintenance. Consequently a depot accounting and allocation procedure had to be developed to provide visibility by WUC to the component removal/replacement level for work performed in all depot maintenance programs on aircraft and engines. A second major difficulty was incomplete and not very accurate data on material usage, and an arbitrarily selected repair cost calculation, used in the 3-M system which provides data to MS. Lack of enforced and complete reporting, and lack of adequate data processing facilities for handling material data appeared to be the causes of the problem. The near term solution selected to this problem was the use of MCM procedures which use statistical means to improve this data. In the longer term, source data automation to guarantee identification and appropriate processing of all materials used in maintenance, was identified as the appropriate solution mechanism. The proposed Naval Aviation Logistics Command Management Information System (NALCOMIS), which will provide automation and completeness of

source data information, is in development for this purpose. A third MS related problem was lack of ability to provide aircraft and engine rework data within their appropriate WBS structures. Other difficulties were encountered, analogous to those experienced by the Air Force VAMOSC/OSCER team, including need for developing simplified allocation schemes, automating some particularly troublesome manual data sources, dealing with incomplete reporting (both as to work performed as well as level of breakout), some usage and cost data based on "standard" values rather than actuals, and data source systems not recently exercised or verified.

Development of a complete CIS to meet the VAMOSC objectives was phased by the Navy VAMOSC planners into near term and far term implementation objectives. For the near term, most of the current reporting procedures are maintained but adapted to meet critical VAMOSC requirements. Algorithms employed by the computer programs to obtain data summaries are generally analogous to those used in the earlier A-7E FY 74 exercise. The long range MIS is planned to be essentially a fully computerized system, in which "major evolutionary" changes would be made in the cost accounting and data collection systems now is use. Several of these were discussed in the previous paragraph.

Implementation of the TSS and MS required selection of development sites, development activities, and permanent sites and activities. Naval Air Development Center (NADC) is the development site for both TSS and MS. ISI is the TSS developer and NADC was selected to develop MS. The operational sites and activities for TSS and MS are NAVCOMPT and NADC, respectively.[4.C.2]

The Navy VAMOSC effort has remained on schedule. The system specifications, coding, checkout and verification, and delivery of the VAMOSC output reports for FY 75 data were completed at the end of 1976. The FY 76 data reports were provided in April 1977 as expected, and the FY 7T data remains planned for July.[4.C.3] Near term VAMOSC-AIR development efforts for TSS and MS are thus complete pending delivery of final documentation in July, and production usage has essentially begun.

Sample top level outputs of TSS and MS for C-117D aircraft costs during FY 76 are shown in Appendices E and F, respectively.

VAMOSC-AIR results have already been used before the DSARC. Just last month in the AV-8B project, VAMOSC data was used to the 2nd digit (system level) WUC, for the Milestone II review. For the Milestone I DSARC review, however, LCC had been estimated using the NARM CER modelling approach. To permit cost track to be maintained, an updated NARM LCC estimate was required in addition to VAMOSC results.[4.C.3]

Efforts to validate VAMOSC-AIR will begin shortly. A user awareness manual is planned for completion in mid May. The seven month closeout period, compared to the original objective of 90 days is considered of some concern, and estimates of costs required to reduce this will be prepared soon. The source of the problem here is that seven of the source data systems are currently manual and require four months for collection and hand transcribing to desired formats.

As a final note, the Navy's VAMOSC-SHIPS efforts were initiated formally last October. In January 1977, the NAVSEA VAMOSC-SHIPS office was established. Details of final report timing and funding have not yet been determined. Some concern exists with the fact that not all maintenance actions are reported under current systems.

SECTION V

INNOVATIVE APPLICATIONS OF AFFORDABILITY MANAGEMENT IN CURRENT SYSTEM ACQUISITIONS

Procurement Techniques for Affordability

Thus far in this paper, we have addressed the requirements for managing for system affordability, and providing means for reliable O&S cost prediction so that affordability management can be successful. In this section we discuss a third critical element for obtaining affordable defense systems: procurement techniques for system affordability. Following this are examples of a current systems acquisition in each of the Air Force and Navy in which O&S cost considerations have a much greater influence than they have had in the past. These examples were selected as representing a new sensitivity to O&S costs, and are not meant to imply that other current weapons system acquisitions are not using similar techniques to some degree.

A variety of potential means can be employed for encouraging contractors to develop products with lower LCC. The system specification itself can include the desired and required values for life cycle cost (or O&S cost) and/or life cycle (O&S) cost factors (such as reliability, manpower levels, etc.), thereby committing the contractor to achieving this level of affordability. However since O&S costs, for example, are accumulated in future years, means for realistic evaluation must be included in the former case, while rational methods for allocating quantitative values are required in the latter. An LCC model (such as LSC as discussed in Section III) can be given to contractors to aid in

design tradeoffs, but if this model is not sufficiently realistic, some risk exists that "gaming" (i.e., "minimizing" costs according to the way the model works) by the contractor may not lead to the desired solution. The contract also can include provisions for Design-to-Cost management techniques in the O&S area, such as discussed in Section II, but the previous comments may apply here too unless improved cost estimating methodologies are utilized.

Provisions for regular LCC reporting, and for requiring trade studies with LCC as a driving parameter (equal to performance and schedule) have been used to focus attention on the O&S cost area. Requirements in the RFP for an LCC management approach have also been helpful. The use of contractual incentive fees and award fees based on O&S costs or O&S cost factors, as measured in some specified way either in the field or in operational or laboratory testing has been considered fairly successful. Experiments with Reliability Improvement Warranties (RIW) and Support Cost Guarantees apparently need further analysis before definitive conclusions are reached. Moderate to heavy weighting of LCC (O&S costs) or LCC cost factors in source selection, provided that sufficient means exist to reliably discriminate O&S cost differences among various design alternatives, also helps yield system designs more responsive to affordability considerations. Reference 5.A.1 examines many of these alternatives in greater detail.

Advanced Medium STOL Transport (AMST)

The Air Force's AMST project[5.B.1] provides a new generation transport aircraft intended to modernize the tactical airlift force. It has

completed two of four program phases. The technology prototype program was conducted to verify the powered lift concepts, and included two aircraft per contractor (Boeing and McDonnell Douglas). A twelve to eighteen month period involving funded contractor LCC studies with both airframe contractors and both engine contractors will soon end. The RFP for the "minimum Engineering Development" phase, a small scale version of full scale engineering development, will be released shortly. No new aircraft will be produced during this phase; the existing technology prototypes of the winning contractor will be modified to the production aerodynamic configuration.

This program has been seriously concerned from its initiation with LCC as a primary design objective. The program stretchout has helped in putting meat into making designing-to-LCC a viable tool. AMST has adopted many of the techniques mentioned in the introduction to this section.

The primary goal was to satisfy requirements with the least LCC. To achieve this goal, the contractors were required to perform trade studies on their primary cost drivers to develop alternatives which could reduce costs. At the same time models were used by the project office to examine user (MAC) demands and requirements in terms of their O&S cost impact, and force reconsideration of certain cost driver requirements. LCC was monitored regularly and was the key design management control variable. This approach was applied vigorously in the early acquisition phases of AMST development because it was recognized that as the design becomes firm, payoffs from design modifications are reduced increasingly sharply.

This design management procedure was implemented by providing each contractor with the same overall O&S cost model and permitting each to apply more detailed models at the lower hardware/logistic support indentures. Each contractor then exercised these models to provide the Air Force with a list of equipments from among the whole AMST system which were the primary cost drivers. (As stated in several places, about 20% of the items provided 80% of the potential for O&S cost reduction.[5.B.2]) The Air Force then identified a collection of system elements for which the contractors performed trade studies to develop more afforable, satisfactorily performing, alternatives. It is estimated[5.B.2] that up to a 40-to-1 return on investment could be realized in some areas of the AMST design. It should be noted that to accommodate this minimum LCC management strategy, looser thresholds around the DTC (Unit Production Cost) goal have been proposed, which some critics viewed as a means to relax discipline around the acquisition costs.[4.B.6]

Discipline through this technique enabled better selection of design elements as well as some flexibility in AMST requirements. When the user wished to change requirements, he received back an O&S cost impact. An initial requirement existed that 100 landings must be able to be made without tire deflation, in a wet sod field before the rut characteristics were to become too severe. When the resulting aircraft design requirements were shown to cause a significant fuel consumption penalty, and when the frequency of this occurrence was considered, the user backed off and allowed some tire deflation. When a funding cut occurred early in the prototype program, the aircraft program was no

longer viable within the new cost limits. It was found that if the user could back off slightly on the speed requirement, then a less expensive straight wing could be used rather than a swept wing. This was done and the program remained alive. In the design area, LCC considerations resulted in the production aircraft having interchangeable wheels/tires in all positions, in a significantly reduced parts count in many subsystems, enabled design simplification, and even resulted in a changing some AF practices to correspond more closely to commercial ones (e.g., only selected fasteners need be dipped in wet paint in order to prevent corrosion).[5.B.1]

The basis for awarding the development contract is primarily LCC. This includes development costs, weapons systems acquisition costs, O&S costs, and support investment costs (e.g., common support equipment, training, initial spares, etc.)

For the coming development phase, an LCC program is planned analogous to that used on the Navy's F-18 project. A $2M award fee is planned for the area of management with special emphasis on LCC. An additional $8M is awardable based on the results of two operational readiness evaluations which emphasize O&S cost factors such as maintenance hours per flying hour, availability, mean down time for maintenance, and mean time between maintenance actions. The first seven production aircraft will form a minisquadron for a 30-day test, and the aircraft will be flown in a specified fashion for about 600 hours during the flight test program simulating 23 peacetime days and 7 wartime days. Maintenance will strictly be done by blue suiters.

The AMST adoption of LCC management appears convincing and successful, and has obtained the commitment of the management of two large contractors as well as that of the Air Force.

Over-the-Horizon Remotely Piloted Vehicle (OTH RPV)

The Navy's OTH RPV program aims at providing a ship based RPV to obtain a significant enhancement in OTH target detection and targeting. The RFP is to be released shortly for a combined Conceptual and Validation phase, starting September 1977, in which two competing contractors will design, build, and test five prototypes each. The first DSARC review is planned prior to initiation of the subsequent full scale development (FSD) phase. About five to seven proposals are expected, with the offerers having had a preliminary statement of work and RFP for some time in order to let them develop their ideas. Currently, because of the uniqueness of the OTH RPV system, no concept is defined.[4.C.3]

As a totally new weapon system element within the Navy, with few preconceived ideas as to structure and requirements allocations, the RPV provides an opportunity for maximum contractor and RFP freedom and innovation in structuring both the RPV system itself as well as the acquisition management process. Also, because the RPV system is only entering the conceptual and validation phases, the potential impact and savings resulting from a design management approach in which outyear costs are key control variables are maximized.

The RPV program is particularly exciting in terms of the role affordability will play in its development. The approach selected blends together almost all of the techniques discussed in the introduction

to this section. Because no historical data base exists from which to build, a progressive approach to establishing and validating needed design tools and models is melded into the affordability assurance plan.

RPV cost and design management is based[5.C.1] on evaluating, tracking, and setting both goals and thresholds on four cost parameters: DTC Unit Production Cost (UPC), O&S cost, ILS acquisition costs (spares, ground support equipment, publications, etc.), and cost driver design elements. In all trade studies and evaluation of design alternatives, changes to each of these parameters must be quantified. In making a design decision, the overall cost vs technical performance package must be appropriately considered. In stressing the importance of the outyear cost considerations, the RFP states that "policy is that unit production cost goals must not be achieved at the expense of total ownership cost" and that "the overall design must ensure achievement of UPC goals without jeopardizing LCC." The approach taken and the plan for implementation, which is discussed below, are consistent with the philosophy and intent of the 1976 Clements memo and the new draft DOD directive discussed in Section II.

LCC (O&S costs, ILS acquisition costs, DTC UPC, and RDT&E costs) considerations are major components of the current RFP for the conceptual/validation phase, the requirements for the corresponding proposal, the source selection process, the performance of the conceptual/validation phase efforts, the RFP and proposal for the FSD phase, the source selection for FSD, and the conduct of the FSD phase efforts. To explain the affordability management plan, it seems best to work backwards from the FSD phase in to the current RFP provisions for the first phase.

During FSD, as in the conceptual phase, trade studies will be performed in which performance, schedule, and the cost parameters indicated above, as well as the key design cost drivers, are considered in selecting among design alternatives. To allow the outyear cost parameters to be quantitatively evaluated, a cost model will be utilized during FSD which was progressively developed by the contractor and approved by the Navy during the conceptual phase, and which provides for model revisions, and updating and replacement of estimated cost and parameter values by actuals and/or improved estimates as they are measured and/or developed during FSD. The FSD program will be incentivized in terms of parameters identified in the Incentive Program conducted during the Conceptual/ Validation (C/V) phase. This program is to determine the key cost driver elements and their impact on affordability, much as was done in AMST prior to its FSD. Based on the demonstration plan prepared during C/V, the incentivized parameters, as well as LCC and Logistic Cost targets themselves, will be progressively demonstrated according to agreed upon methods and procedures.

Source selection for FSD will rely very heavily on the life cycle cost considerations, including estimates of O&S cost, ILS acquisition costs, UPC, and cost driver parameter values. An as of yet unresolved question exists as to which models to use for outyear cost estimation - a Navy model provided upon outset of C/V, or a new model based on contractor developed/Navy approved models completed at the end of C/V.

The C/V phase effort is aimed at providing a design structure which best marries overall affordability and performance, and which prepares

the needed groundwork for the FSD efforts described above. Toward this end, extensive trade studies are conducted which are evaluated in terms of the performance and affordability parameters used in the FSD phase. However, the models used during C/V are Navy supplied, rather than contractor developed, and are updated periodically when new information and data justify. The initial Navy model will be a composite of Navy efforts and contractor models included in the C/V proposals. Trade studies are not limited to the design characteristics controlled by the contractor, but instead must include support and maintenance concept issues, as well as operational scenario, usage, and other characteristics which serve as primary cost drivers. The objective here is to provide an overall optimal and affordable system design, logistics support structure, and utilization doctrine. During C/V, the contractors develop their detailed cost models. These models are submitted and reviewed for approval by the Navy at six months intervals. The completeness and accuracy of these models will be important in FSD source selection and conduct of the FSD trade studies and the principles of good modelling as indicated in Section III apply. Verification of relationships and parameter values used in the models is an important Navy requirement, and the Logistic Support Analysis (LSA) program requires examination of actually experienced costs for similar items in the fleet. This validation is consistent with the guidelines of using accumulated system, subsystems, and component cost data that are embraced by the VAMOSC objectives, as discussed in Section IV. Confidence intervals are to be placed on all model inputs and outputs.

Tracking and reporting of LCC and cost driver parameters, as well as other identified items, are required on a monthly basis to make visible the status of development in terms of performance and affordability. The Incentive Program Plan, which specifies the Incentive Program used during FSD as discussed above, is developed in the C/V phase. This includes identification of design, support, and operational cost drivers and constraining elements, means to measure these drivers and constraints as the contract progresses, and sensitivities of performance and affordability to these items. Cost breakdowns during C/V are based on the WBS structure, and are to the fifth level for FSD and production, and to the fourth level beyond that.

Source selection for the C/V phase includes evaluation of contractor responsiveness and knowledge in the affordability area, and an assessment of the expected contractor performance during C/V in performing and integrating affordability objectives as described above.

To provide a basis for this evaluation, the current RFP for the C/V phase carefully delineates the role affordability will play, and how it will play it, during the RPV development efforts. A Life Cycle Cost volume is required from each offeror in which he must present his LCC Management Plan, an estimate of LCC (justified and defended in a manner specified in detail in the RFP, and including certain elements as defined in the RFP), an estimate of ILS acquisition costs (with appropriate explanations), and a plan for developing the LCC Incentive Program. Potential cost tradeoff analyses in which LCC will be a key consideration are to be identified. The proposed techniques and models for LCC

evaluation and a plan for their further development are to be included. In identifying sufficient LCC model description, the RFP asks that it "permit the government to duplicate the results and apply the model to the offeror's proposed system and to similar existing Navy systems." The LCC/UPC/Project Cost reporting system plan and content are required. The initial design constraint includes a limitation of a fixed amount (say, for example, $1M) of funds for support costs per ship that can be made available.[4.C.3]

Two final issues need discussion. In selecting among alternatives in RPV trade studies, a balance of all parameters is considered, so that if a $500 increase in LCC, for example, allows a doubling of RPV range or a very large increase in growth potential, the higher LCC alternative might be selected. Second, the LCC model to be used in source selection for FSD should, in the author's opinion, be the most realistic model available. Use of the primitive model specified by the Navy at initiation of C/V provides the contractors with a definite yardstick early in the game. Since the objective of the contractor must be to win the FSD contract, however, use of the primitive model as the basis for LCC prediction in source selection may drive his design in a direction somewhat different from that of actual maximum affordability. The author recommends therefore that the FSD source selection use a Navy developed composite model built progressively during the C/V phase by incorporating the best portions of the contractor developed models. A periodic review of this Navy model with the competing contractors should be held to assure their participation, and to obtain their comments regarding the model's content and utilization.

SECTION VI

IMPACT ON DEFENSE CONTRACTORS

Two contractors were contacted with regard to the perceived impact that the new O&S cost initiatives, particularly the DOD draft directive, would have on their operations and on the quality and cost of defense system products. Several responses from different management areas were received and were consistent with each other and with related results of a joint industry study involving LCC.[6.1,6.2] Because of the small sample involved, a more thorough study in this area may be a useful addition to the work done to date.

A strong consensus exists that these steps toward acquiring affordable systems are beneficial for DOD and the defense community, and are needed to counteract the larger fraction of resources being swallowed by O&S cost requirements. Industry will be responsive to this increased emphasis on affordability to the degree that the awarding, incentivizing, and technical management of contracts are found to reflect the policies stated in the directives, and the degree to which funding is provided for affordability efforts. Since contractors must win contracts to make a profit, the key driving factor in the O&S improvement area will be the degree to which it impacts source selection and contract profits. Some concern exists that the relationship between DTC and O&S cost goals needs further clarification. Similarly, additional guidance is required to address the "current vs. future dollars" issues as they impact source selection.

Contractor managers believe that rigorous implementation of the O&S cost policies could be effective in reducing the LCC of new systems. Effectiveness would be significantly affected, however, by the quality of the participating contractor and customer personnel. The impact of the new direction will be felt later rather than sooner.

The need to calculate LCC estimates earlier and more reliably than is generally done currently will require establishment of a cost data bank, improved techniques for O&S cost estimation, means for feeding back this data in useful form to design engineers, and development of revised O&S cost guides. The respondents stated that O&S data often has been impossible to get in the past, that it lacks data on material usage and support, and that a complete overhaul of the DOD accounting system structure may be necessary to access data needed to make design tradeoffs at anything but a very top level. Without finer grained cost information, O&S cost prediction may not help as much as it could in achieving more affordable systems. Even with improvements in this area, uncertainties regarding the O&S impact of systems using new technologies and actual future system employment limit the reliability of cost projections.

The impact on equipment of an increased concern with affordability is expected to be in terms of increased standardization, increased automation, and a lower level of manpower--provided that the reduced manpower requirements of the equipment is translated into reduced manpower requisitions in the field.

The impact on the contractor organization structure reaches several levels. The role of the logistics experts will become more critical,

they will be given more responsibility, and the design organizations will place more emphasis on LCC and ILS skills. With LCC becoming a more significant discipline, the number, quality, and mix of people in the LCC activities will increase. Some of this will reflect a growth in the size of cost management organizations within DOD by counterparts at the contractors' facilities. Expectations exist that the disciplines of Reliability/Maintainability, LCC, ILS, and O&S will be put under one roof to better integrate these activities and obtain a better balance in design. In fact one major defense contractor not queried in this study has recently done just that to effect O&S cost consciousness and efficiencies on an Air Force program.

The emphasis on affordability will engender much greater contractor sensitivity to the O&S cost issue and will result in performing far more tradeoffs, such as those between design for maintainability vs. design for logistic support. Designers will have to make O&S cost analysis a more integral part of their design efforts. The contractors will need to grow or obtain additional capability for O&S costing. They also feel the need to become involved in O&S cost measurement techniques and to devote more space in their proposals to O&S cost issues.

Cautions were issued however that rational cost evaluation procedures must be developed to compare cost analyses from competing contractors, especially if differences exist in the systems being compared and in the parameter values selected for these systems.

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

The challenge of obtaining more affordable defense systems has begun to be tackled. Management initiatives within OSD and the Services are directed toward assuring adequate consideration of affordability in the acquisition process. Innovative procurement techniques aimed at cost control are being applied successfully, and contractors have been responsive to the new direction in cost management. Effort has begun to be applied to overcome two current weaknesses in affordability management: The implementation of VAMOSC by the Services promises to provide the historical operating and support cost data base by weapon system and subsystem needed for outyear cost estimation, tradeoffs, and evaluation. The suggested research to develop improved O&S cost estimation models is a necessary step in assuring that design and support decisions provide the desired cost savings opportunities.

Obstacles remain on the road ahead. Providing more affordable defense system design and logistic support, and implementing the policies needed to fully realize the cost benefits inherent in the improved designs, require the coordinated efforts of the developers, users, support organizations, policy makers, and manpower planners. Unless such integrated efforts occur, the benefits obtained by the new approaches to affordability will not approach the level achievable. This presents a challenge to system development organizations to share their responsibility, and to the user, support, and planning organizations to provide technical

assistance and to have their policies influenced by the results of sufficiently meaningful trade analyses. These roles may impose new requirements on the capabilities and backgrounds of people within these elements.

The important area of O&S cost estimation seems to suffer from lack of a sufficiently complete understanding of how to translate design parameters into operational costs, and how to properly account for manpower and logistics support policy and implementation. Since this is a significant basis for levying specification requirements on O&S (as well as production) cost drivers such as reliability, maintainability, etc., it is imperative that improvements in modelling capability be made. The research program suggested in the draft DOD directive is essential, and must involve participation from the variety of defense system organizations discussed earlier. The use of statistical confidence intervals, along with the cost estimates themselves, would be useful when weighting outyear cost estimates against other factors.

The building of a data base of O&S costs, which is being undertaken by the Services' VAMOSC efforts, is essential for establishing estimating relationships where almost none exist now, enabling improved budgeting, and providing a more realistic basis for design tradeoffs and evaluation. The latter function requires cost visibility at the subsystem and component levels. It is uncertain as to the degree of success the current VAMOSC efforts can achieve along these lines. A reexamination of the whole series of accounting systems may be necessary to assess adequacy for supporting weapon system design objectives. If they are insufficient, a

cost effectiveness study may be advisable to assess the benefits vs. the costs involved in modifying these systems.

The suggested role of affordability as a critical control parameter for creating cost savings opportunities and for limiting unnecessary increases in technical performance provides a suitable balance of weapon system capability and cost. Consideration of logistics support elements and manpower and defense planning and policy, along with design parameters, is essential for minimizing overall costs. In some cases, for example, improvements to spares management policies, or simpler hardware design, may provide the cost savings which might otherwise be obtained through more stringent, and perhaps more expensive, reliability allocations. Regular feedback to the user as to the cost implications of certain cost sensitive requirements may allow, as in AMST, a relaxation in non-critical areas at a considerable cost savings. Progressively updating O&S cost estimates to reflect the results of testing and other new knowledge may improve the results of subsequent trade studies.

The previous discussion has emphasized the multifaceted aspects, disciplines, and organizations involved in designing affordable systems. Because of the scope of efforts involved and the degree of organization coordination required, the author recommends, in concurrence with the DOD draft directive, that a specific office be established within each Service to provide overall direction and management to the Service's affordability efforts. A general or flag officer should be selected to head this office, which would be dissolved when the affordability disciplines and tools have been suitably developed.

LIST OF REFERENCES*

SECTION II.

2.A.1 DOD Memorandum "Design to a Cost Objectives on DSARC Programs," 18 June 1973.

2.A.2 DOD Directive 5000.28, "Design to Cost," 23 May 1975.

2.A.3 "Application of Design-to-Cost Concept to Major Weapon System Acquisitions," GAO Report to the Congress, PSAD-75-91, 23 June 1975.

2.A.4 "Joint Design-to-Cost Guide, Life Cycle Cost as a Design Parameter," NAVMAT P5242, DARCOM P700-6, AFLCP/AFSCP 800-19, 11 June 1976.

2.A.5 DOD Directive 5000.1, "Acquisition of Major Defense Systems," 13 July 1971, reissued on 22 December 1975. (Its reissuance on 18 January 1977 does not directly relate to the discussion in the text.)

2.A.6 Deputy Secretary of Defense Memorandum, "Reduction of Outyear Operating and Support (O&S) Costs," 28 February 1976.

2.A.7 DOD Directive 5000.2, "Major System Acquisition Process," 18 January 1977.

2.B.1 DOD Directive xxx.xx (draft, proposed), "Operating and Support Cost Management in the Systems Acquisition Process," (Mr. Al Frager, ASD(I&L)).

2.C.1 "Acquisition Management: Life Cycle Cost/Design-to-Cost Implementation," AFR 800-11 (draft, revised), (Lt Col Paul Clanton).

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*To assist the reader, references are segregated according to Section - Subsection of this paper to enable ready identification of material by specific categories.

SECTION III.

3.1 Capt D. E. Collins, USAF, "Models A Key to Air Force Life Cycle Cost Implementation," Defense Management Journal, January 1976, pp 5459.

3.2 ________, "Analysis of Available Life Cycle Cost Models and Their Applications," Joint AFSC/AFLC Commanders' Working Group on Life Cycle Cost, ASD/ACL, June 1976.

3.3 R. M. Genet, "Weapon Systems Life Cycle Costs and Department of Defense Policy," PRAM Program Office, WPAFB, OH, 3 May 1976. (rough draft)

3.4 J. D. Gibson, "Understanding and Evaluating Life Cycle Cost Models," Joint AFSC/AFLC Commanders' Working Group on Life Cycle Cost, ASD/ACL, October 1975.

3.5 L. J. Menker, "Life Cycle Cost Analyses Guide," Joint AFSC/AFLC Commanders' Working Group on Life Cycle Cost, ASD/ACL, November 1975 (especially Chapter 5 and Appendix C), WPAFB, OH.

3.6 Life Cycle Costing Procurement Guide (Interim), Office of the Assistant Secretary of Defense (OASD), LCC-1, July 1970.

3.7 Casebook Life Cycle Costing in Equipment Procurement, OASD, LCC-2, July 1970.

3.8 Life Cycle Costing Guide for System Acquisitions (Interim), OASD, LCC-3, January 1973.

3.9 "Operating and Support Cost Guide for Army Materiel Systems," Department of the Army Pamphlet 11-4, April 1976.

3.10 "Standards for Presentation and Documentation of Life Cycle Cost Estimates for Army Material Systems," Department of the Army Pamphlet 11-5, May 1976.

3.11 "Life Cycle Costing, A Selected Bibliography by Lucille McClure," Martin Marietta Aerospace, Orlando, FL, RB 330-1, October 1976.

3.12 Lt Col G. E. Gabel, USAF, "Capitalizing on Cost-Reducing Opportunities," Defense Management Journal, January, 1977, pp 24-29.

3.13 D. M. Johnston, "Men, Myths and Machines, or 'All the Ships at Sea'," Defense Management Journal, October 1976, pp 17-22.

3.14 MAJ T. K. Moore, USAF, "Corrosion and Fatigue: Problems in Life Cycle Costing," Defense Management Journal, January 1976, pp 48-53.

3.15 R. R. Shorey, "Managing Downstream Weapons Acquisition Costs," Defense Management Journal, January 1976, pp 10-18.

SECTION IV.

4.A.1 Fiscal Year 1975 MBO 3-12, "Visibility and Management of Support Costs."

4.A.2 Fiscal Year 1976 MBO 9-2, "Visibility and Management of Support Costs."

4.A.3 "OSD Requirements for Visibility and Management of Support Costs," August 1975.

4.A.4 Army Plan to Establish O&S Cost Goals for Selected Material Systems, 14 May 1976, DCA-R-26 Directorate of Cost Analysis, Comptroller of the Army.

4.A.5 ________, (Revision 1), 28 January 1977, DCA-R-49, Directorate of Cost Analysis, Comptroller of the Army.

4.A.6 "Tasking Directive - Development and Implementation of Army Operating and Support Cost Efforts," 19 October 1976, W. M. Allen and Maj Gen R. H. Thompson, DALO-SMZ-A.

4.A.7 ________, 1 March 1977, J. J. Leonard, DCOA, DACA-ZB.

4.B.1 "Visibility and Management of Support Costs, MBO 9-2," Viewgraph presentation for the O&S Cost Analysis Symposium, May 1976, prepared by Cost Factors Branch, Management Analysis Directorate, USAF Comptroller Organization.

4.B.2 Preliminary Draft, OSCR Handbook and Users Manual, November 1976 prepared by Cost Factors Branch, Management Analysis Directorate, USAF Comptroller Organization.

4.B.3 Ms. Vivian Swinson, Cost Analysis Division, Directorate of Management Analysis, Comptroller Air Force. Interview with the author, February 1977. Ms. Swinson's review of OSCER problems was used extensively in Section 4.B.

4.B.4 "OSCR System Applications Analysis," Logistics Management Institute Task 76015, December 1976, J. J. Domin and C. A. Webster.

4.B.5 "Program Management Directive for DOD MBO 9-2, 'Visibility and Management of Support Costs' - Subsystem Component Level," PMD No. L-Y 7049 (1), 10 February 1977, authored by Lt Col P. Clanton, signed by Brig Gen E. T. O'Loughlin.

4.B.6 Lt Col Paul Clanton, Installation and Logistics, USAF Air Staff. Interviews with the author, March and April 1977.

4.C.1 "Visibility and Management of Support Costs," US Navy Chief of Naval Operations, Final Report, April 1975.

4.C.2 "VAMOSC-AIR (Near-Term) Implementation (VAI) Project Plan," Department of the Navy, Air Systems Command, 14 April 1976, R. E. Houts, AIR 4105C.

4.C.3 R. E. Houts, Advanced Development Branch, Logistics Management Division, Naval Air Systems Command. Interviews with the author, February and April 1977. These discussions provided material for Sections 4.C and 5.C.

SECTION V.

5.A.1 J. E. Kennan, Jr., and L. Menker, "Life Cycle Cost Procurement Guide," Joint AFSC/AFLC Commanders' Working Group on Life Cycle Cost, ASD/ACL, July 1976, WPAFB, OH.

5.A.2 J. D. Gibson, "Supplemental Life Cycle Costing Program Management Guidance, " Life Cycle Cost Office, Comptroller, Aeronautical Systems Division, January 1977, WPAFB, OH.

5.B.1 Capt Thomas May, AMST Project Office, WPAFB, OH. Discussions with the author, March and April 1977. These discussions provided most of the material discussed in Section 5.B.

5.B.2 COL E. P. Eaton, USAF, "Let's Get Serious About Total Life Cycle Costs," Defense Management Journal, January 1977, pp 2-11.

5.C.1 Request for Proposal, Over-the-Horizon Remotely Piloted Vehicle, April 1977, Naval Air Systems Command (draft). This document, and interviews with R. E. Houts (reference 4.C.3) provide the basis for the material in Section 5.C.

SECTION VI.

6.1 Dr. J. J. Bennett, "Industry Feedback on Life Cycle Cost," Defense Management Journal, October 1976, p 38.

6.2 A. M. Frager, "Life Cycle Cost: An NSIA Review," Defense Management Journal, October 1976, pp 39-40.

APPENDIX A: OSCER COST ACCOUNT CATEGORIES

OPERATIONS

1XXX Base-Level Operations

11XX Flying Operations

1110 Aircrew
1115 Unit Administration/Life Support
1120 Operations Staff
1130 Aviation POL

12XX Weapon System Maintenance

1210 Consolidated Maintenance
1220 Organizational Maintenance
1230 Field Maintenance
1240 Avionics Maintenance
1250 Munitions Maintenance
1290 Chief of Maintenance

13XX Base Operations Support (Except RC/CC 5XXX)

1310 Real Property Maintenance Activity (RPMA)
1320 Base Communications
1330 Base Support (housekeeping)

15XX Tactical Air Control, TAC only (future)

SUPPORT

2XXX Depot Operations

21XX Depot Maintenance (IF) - Organic Plus Contractual

2110 Complete Aircraft
2120 Engine Repair
2130 Acft/Engine Accessories & Component Repair
2140 Electronics and Communications Repair
2150 Armament Repair
2160 AGE Repair

22XX Director of Distribution (D/D) - PEC 71111F

23XX Director of Materiel Management (D/MM) - PEC 71112F

24XX Director of Procurement (D/P) - PEC 71113F

25XX ALC Base Operating Support (Except RC/CC 5XXX)

2510 ALC Real Property Maintenance
2520 ALC Base Communications
2530 ALC Base Support (housekeeping)

26XX Second Destination Transportation - PEC 78010F

2610 Via ASIF--Other
2620 Via MSC--(former MSTS)
2630 Via Commercial Air
2640 Via Commercial Surface CODE
2650 LOGAIR
2660 Port Handling Cost--MTMTS
2670 Other Transportation Costs--Packing, Crating, Temporary Storage

3XXX Recurring Investments (Appropriations 3010, 3020 and 3080)

31XX Exchangeable Replacement

33XX Common Ground Support Equipment (GSE)

34XX Training Munitions

35XX Modifications

3510 Modification (Class IV and V)
3520 Modification Initial Spares
3530 Component Improvement

4XXX Acquisition and Training Cost by Career Field

41XX Flying Status

411X Officers

4111 Fixed 1/
4112 Variable 2/

412X Enlisted

4121 Fixed 3/
4122 Variable 5/

42XX Non-Flying Status

421X Officers

4211 Fixed 4/
4212 Variable 5/

422X Enlisted

4221 Fixed 3/
4222 Variable 5/

5XXX Other Personnel Support

51XX PCS

5110 Officers
5120 Enlisted

52XX Medical

5210 Officers
5220 Enlisted

Notes to Appendix A:

1/ Officer Acquisition (USAFA, ROTC, OTC, etc.); UPT; UNT; Basic Survival Training; Water Survival Training

2/ CCTS

3/ Enlisted Basic Training (Lackland AFB)

4/ Officer Acquisition (USAFA, ROTC, OTS, etc.)

5/ Technical School Training at ATC/s Tech Training Centers

SUFFIX CODING STRUCTURE

.00 No Suffix Coding

.10 Military Labor

- .11 Officers Pay and Allowances (Active Duty)
- .12 Enlisted Pay and Allowances (Active Duty)
- .13 Officers Pay and Allowances (AF Reserve) - MAC ONLY
- .14 Enlisted Pay and Allowances (AF Reserve) - MAC ONLY
- .15 Officers Pay and Allowances (ANG)
- .16 Enlisted Pay and Allowances (ANG)
- .17 Officers Pay and Allowances (Military Trainee)
- .18 Enlisted Pay and Allowances (Military Trainee)

.20 Civilian Labor (Includes Direct Hire Local Nationals)

- .21 Civilian Pay and Other Compensation (EEIC 39X Except 391)
- .22 Overtime (EEIC 391)

.30 Civilian Labor (Includes Indirect Hire Local Nationals)

- Indirect Hire Labor Contracts with Foreign Governments Only - EEICs 511 and 512. Includes: base pay, lump sum leave payments, holiday pay, night work differentials, bonuses, overtime and separation allowances.

.40 TDY Expense

- .41 AFSC Transportation Expenses (EEIC 407)
- .42 Commercial Transportation Expenses (EEIC 408)
- .43 Per Diem Expenses (EEIC 409)

.50 Supplies, Materiel and Expense Equipment

- .51 Stock Fund Supplies and Materiel Issues (EEIC 60X; $X \neq 1$, 2, or 4)
- .52 Base Procured Supplies and Materiel Issues (EEIC 61X; $X \neq 4$)
- .53 Stock Fund Expense Equipment (EEIC 63X; $X \neq 4$)

.60 Reserved

.70 Contractual Expenses (AFLC Only)

- .71 Contractual Services (Labor & Material)
- .72 Government Furnished Material (GFM) - Expense
- .73 Other Contract Expenses

.80 Base Command Contractual Expenses (Excl AFLC)

.90 Other Expenses and Miscellaneous Cost

- .91 Administrative - Depot Maintenance (Acct 21XX)
- .92 RPM, Other
- .93 COMM, Other
- .94 Base Operation, Other
- .95 Wing/Base Commander, Other
- .96 D/D, Other
- .97 D/MM, Other
- .98 D/P, Other

APPENDIX B: OSCER FY 75 OUTPUT FOR C-141A

OPERATING AND SUPPORT COST REPORT - (OSCR) FY 75 AS OF 16 JUN 76

BASE LEVEL OPERATIONS

MDS	UNIT	CMD	LOCATION		FLY HRS	LANDINGS	SORTIES	AVG POSS
C141A	0060 MAL WG	MAC	TRAVIS	AFB	44038	23484	10988	34.83

	OFFICER	AIRMEN	CIVILIAN	SUPPLIES	TDY	CONTRACT	OTHER	TOTAL
FLYING OPS	10144350	18170348	730827	36179185	913889			58137719
AIRCREW	4428431	3663729		1219365				9311525
UNIT ADMIN/SPT	2346088	2810084						5156092
OPS STAFF	3369911	3696535	730827					7797273
FOL				34959820				34959820
TDY					913089			913089
WEAPON SYST MAINT	449106	9816049	2934102	3971067	70888			17241212
CONSOLIDATED	27299	487718		68247				583264
ORGANIZATIONAL	162471	3075055	305360	925951				4468837
FIELD	75291	3669901	1761034	2231881				7738107
AVIONICS	77933	1670058	562839	716368				3027189
MUNITIONS								
MISSILE								
CHIEF	186112	993317	304878	28628				1432927
TDY					70888			70888
BASE LEVEL OPS	330604	3615578	4287076	1125578	19419	551828	316173	10246250
REAL PROP	49482	628995	2129299	662935	3406	449111	283782	4206930
COMMUNICATIONS	26170	688513	86242		3578			804503
HOUSE KEEPING	254952	2298070	2071537	462643	12435	102709	32471	5234817
TRAINING							12318943	12318943
FLYING STATUS							6276960	6276960
OFFICER							5394490	5394490
GEN ACQ + TRN							4779144	4779144
ADVANCED TRN							615346	615346
AIRMEN							882470	882470
GEN ACQ + TRN							229152	229152
ADVANCED TRN							653318	653318
NON FLYING STATUS							6041983	6041983
OFFICER							1939722	1939722
GEN ACQ + TRN							1271912	1271912
ADVANCED TRN							667810	667810
AIRMEN							4102261	4102261
GEN ACQ + TRN							978436	978436
ADVANCED TRN							3123825	3123825
OTHER PERS SUPPORT							4537242	4537242
PCS							1162122	1162122
OFFICER							819962	819962
AIRMEN							342160	342160
MEDICAL							3375120	3375120
OFFICER							2215584	2215584
AIRMEN							1159536	1159536
TOTAL BASE LEVEL	10924060	23601975	7952007	41275830	1003316	551828	17172358	102481366

AFLC DEPOT MAINTENANCE

AS OF 16 JUN 76

MDS	UNIT ID	CMD	LOCATION		FLY HRS	LANDINGS	SORTIES	POSS
C141A	0060MALWG	MAC	TRAVIS	AFB	44030	23484	10998	34.93

	AIRFRAME (INCL PDM)	ENGINES	ACCESSORIES	ELECT + COMM	ARMAMENT	GROUND SUPPORT	TOTAL
MILITARY LABOR	50708	11385	45794	6004			113801
FIXED	7606	1555	6445	847			16453
VARIABLE							
MDS	43102		12782	1679			57563
FLY HRS		9830	26477	3478			39785
SORTIES		AVAILABLE ON REQUEST					
CIVILIAN LABOR	1253764	145436	1528719	187459			3115378
FIXED	188065	19867	215566	26434			449932
VARIABLE							
MDS	1065699		427538	52427			1545664
FLY HRS		125569	885615	108598			1119782
SORTIES		AVAILABLE ON REQUEST					
EXPENSE MATERIAL	115115	82009	1254999	206976			1659099
FIXED	17257	11203	176968	29186			234624
VARIABLE							
MDS	97848		350987	57885			506720
FLY HRS		70906	727844	119905			917755
SORTIES		AVAILABLE ON REQUEST					
OVERHEAD	1227402	189037	1441147	176482			3034064
FIXED	184110	25823	203217	24886			438036
VARIABLE							
MDS	1043292		403047	49357			1495696
FLY HRS		163214	834843	102239			1100336
SORTIES		AVAILABLE ON REQUEST					
CONTRACT SERVICE	16072		317792	2187		2788	338679
VARIABLE							
MDS	16072		103467	686		882	121107
FLY HRS			214325	1421		1826	217572
SORTIES		AVAILABLE ON REQUEST					
GOVT FURN MAT	1934		166204	1739		1575	171452
VARIABLE							
MDS	1934		54113	566		513	57126
FLY HRS			112091	1173		1062	114326
SORTIES		AVAILABLE ON REQUEST					
DM-TOTAL	2664995	427867	4754565	580767		4283	8432477

AS OF 15 JUN 76

DEPOT OPERATIONS

MDS	UNIT	CMD	LOCATION		FLY HRS	LANDINGS	SORTIES	AVE POSS
C141A	0060 MAL WG	MAC	TRAVIS	AF3	44030	23484	10988	34.83

	OFFICER	AIRMEN	CIVILIAN	SUPPLIES	TDY	CONTRACT	OTHER	TOTAL
							1456656	1456656
RECURRING INVESTMENTS							1153496	1153496
EXCHANGEABLES							ON REQUEST	
FLY HRS								
SORTIES							293373	293373
TRAINING MUNITIONS								
MODIFICATIONS							9787	9787
COMPONENT IMPROVEMENT								
MOD INITIAL SPARES								
ALC OPS	21536	87059	443217	91813	3499	219527	41887	908458
REAL PROP	4366	26795	221083	73242	408	206834	40612	573348
COMMUNICATIONS	3471	26454	44052	3748	1505	286	184	79670
HOUSE KEEPING	13699	33810	178082	14823	1586	12487	1011	255498
ALC DIRECTORATES							153028	153028
DISTRIBUTION							95786	95786
MATERIAL MGMT							41916	41916
PROCUREMENT							15318	15318
SECOND DEST TRANS							156774	156774
TOTAL DEPOT OPS	21536	87059	443217	[illegible]	3499	219527	1888257	2674908
TOTAL UNIT COSTS								113588751

COSTS WHICH ARE NOT DISTINGUISHABLE BETWEEN OFFICER, AIRMEN, CIVILIAN PAY, SUPPLIES, ETC. ARE DISPLAYED IN THE "OTHER" COLUMN. FOR THIS REASON, NO GRAND TOTAL BY COLUMN IS MEANINGFUL. THIS PROBLEM IS CURRENTLY UNDER STUDY.

APPENDIX C: VAMOSC TSS COST BREAKDOWN STRUCTURE

- 1.0 Total Support System Cost Elements (By T/M/S)
  - 1.1 Squadron Operations
    - 1.1.1 Personnel
    - 1.1.2 TAD (Temporary Additional Duty)
    - 1.1.3 Training Expendable Stores
    - 1.1.4 Maintenance Supplies
    - 1.1.5 Personnel Support Supplies
    - 1.1.6 POL (Petroleum, Oil and Lubricants)
  - 1.2 Base Operating Support
    - 1.2.1 Intermediate Maint. Pers. (Nondeploying)
    - 1.2.2 Intermediate Maint. Pers. (Deployable)
    - 1.2.3 Maintenance Supplies
  - 1.3 Depot Support
    - 1.3.1 Aircraft Rework
    - 1.3.2 Engine Rework
    - 1.3.3 Component Rework
    - 1.3.4 Other Rework
      - 1.3.4.1 Miscellaneous Depot Support
      - 1.3.4.2 Engineering Support

1.0 TSS Cost Elements (Continued)

1.4 Training Support

1.4.1 RAG (Replacement Air Group)

1.4.1.1 Personnel

1.4.1.2 TAD

1.4.1.3 Training Expendable Stores

1.4.1.4 Maintenance Supplies

1.4.1.5 Personnel Supplies

1.4.1.6 POL

1.4.2 Operational

1.4.3 Maintenance

1.5 Recurring Investment

1.5.1 Replenishment Spares

1.5.2 Modification Procurement

1.6 Other Functions

1.6.1 NETS (Navy Engineering and Technical Services)

1.6.2 CETS (Contractor Engineering and Technical Services)

1.6.3 Publication Updates

APPENDIX D: VAMOSC MS COST BREAKDOWN STRUCTURE

2.0 Maintenance Subsystem Cost Elements

- 2.1 Squadron (Organizational)
  - 2.1.1 Maintenance Actions (Sched and Unsched)
    - 2.1.1.1 Pay (and manhours)
    - 2.1.1.2 Consumables
  - 2.1.2 Support Action Pay (and manhours)
  - 2.1.3 Technical Directive Compliance Pay (and manhours)
- 2.2 Base (Intermediate)
  - 2.2.1 Maintenance Actions (Sched and Unsched)
    - 2.2.1.1 Pay (and manhours)
    - 2.2.1.2 Consumables
  - 2.2.2 Support Action Pay (and manhours)
  - 2.2.3 Technical Directive Compliance Pay (and manhours)
  - 2.2.4 Surveyed Reparables
- 2.3 Depot (Both Government and Contractor)
  - 2.3.1 Aircraft Rework
  - 2.3.2 Engine Rework
  - 2.3.3 Component Rework
  - 2.3.4 Surveyed Reparables
  - 2.3.5 Technical Directive Compliance Pay (and manhours)

APPENDIX E: TSS SUMMARY FY-76 OUTPUT FOR C-117D AIRCRAFT

NALCOMIS-O+S/VAMOSC-AIR

NAVY AND MARINE CORPS AIRCRAFT COST REPORT BY T/M/S

($ IN THOUSANDS; DATA AS LISTED)

VAMOSC-AIR-TSS FY 1976   T/M/S: C-117D   PAGE 1

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
AIRCRAFT NUMBER	20.0	11.0	3.0	7.0	.0	1.0	.0	.0	.0	42
FLYING HOURS										
REGULAR	8,444.0	3,352.0	1,872.0	2,759.0	.0	168.0	.0	.0	.0	15,795
FLEET READINESS SQUADRON	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
*** TOTAL FLYING HOURS	8,444.0	3,352.0	1,072.0	2,759.0	.0	168.0	.0	.0	.0	15,795

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
ORGANIZATIONAL										
MILITARY PERSONNEL COST	20,021.9	14,006.0	.0	710.6	.0	.0	.0	.0	.0	34,738
CIVILIAN PERSONNEL COST	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
CONTRACT PERSONNEL COST	.0	.0	.1	.0	.0	.0	.0	.0	.0	0
** SUBTOTAL PERSONNEL	20,021.9	14,006.0	.1	710.6	.0	.0	.0	.0	.0	34,738
TEMPORARY ADDITIONAL DUTY	155.3	42.8	.0	33.2	.0	.0	.0	.0	11.7	243
TRAINING EXPENDABLE STORES	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
MAINTENANCE SUPPLIES	430.4	93.0	46.0	121.7	.0	.0	.0	.0	.0	691
PERSONNEL SUPPORT SUPPLIES	82.1	30.4	2.5	12.8	.0	.4	.0	.0	.0	128
POL COSTS	563.7	236.0	72.6	170.2	.0	10.8	.0	.0	.0	1,053
*** ORGANIZATIONAL SUBTOTAL	21,253.7	14,408.4	121.4	1,048.7	.0	11.2	.0	.0	11.7	36,855

BEST AVAILABLE COPY

NAVY AND MARINE CORPS AIRCRAFT COST REPORT BY T/M/S

($ IN THOUSANDS; DATA AS LISTED)

VAMOSC-AIR-TSS FY 1976

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
INTERMEDIATE										
MILITARY PERSONNEL COST	.0	451.6	.0	.0	.0	.0	.0	.0	.0	451
CIVILIAN PERSONNEL COST	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
CONTRACT PERSONNEL COST	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
** SUBTOTAL PERSONNEL	.0	451.6	.0	.0	.0	.0	.0	.0	.0	451
MAINTENANCE SUPPLIES	683.3	279.4	8.1	117.4	.0	4.9	.0	.0	.0	1,093
*** INTERMEDIATE SUBTOTAL	683.3	731.1	8.1	117.4	.0	4.9	.0	.0	.0	1,545

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
DEPOT SUPPORT										
AIRCRAFT REWORK INTRA-DOD	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
AIRCRAFT REWORK COMMERCIAL	361.8	143.6	45.9	118.2	.0	7.1	.0	.0	.0	676
** SUBTOTAL A/C REWORK	361.8	143.6	45.9	118.2	.0	7.1	.0	.0	.0	676
ENGINE REWORK INTRA-DOD	368.6	146.3	46.7	120.4	.0	7.3	.0	.0	.0	689
ENGINE REWORK COMMERCIAL	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
** SUBTOTAL ENG REWORK	368.6	146.3	46.7	120.4	.0	7.3	.0	.0	.0	689

NALCOMIS-O+S/VAMOSC-AIR

NAVY AND MARINE CORPS AIRCRAFT COST REPORT BY T/M/S

VAMOSC-AIR-TSS FY 1976 ($ IN THOUSANDS: DATA AS LISTED) T/M/S: C-117D

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
COMPONENT REWORK INTRA-DOD	231.6	91.9	29.4	75.6	.0	4.6	.0	.0	.0	433
COMPONENT REWORK COMMERCIAL	4.1	1.6	.5	1.3	.0	.0	.0	.0	.0	7
** SUBTOTAL COMP REWORK	235.8	93.6	29.9	77.0	.0	4.6	.0	.0	.0	441
OTHER REWORK MISC DEPOT	181.6	72.1	23.0	59.3	.0	3.6	.0	.0	.0	339
OTHER REWORK ENG. SUPPORT	62.5	24.8	7.9	20.4	.0	1.2	.0	.0	.0	117
** SUBTOTAL OTH REWORK	244.2	96.9	31.0	79.7	.0	4.8	.0	.0	.0	456
*** SUBTOTAL DEPOT SUPPORT	1,210.5	480.5	153.6	395.5	.0	24.0	.0	.0	.0	2,264

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
TRAINING SUPPORT										
FRS MILITARY PERSONNEL COST	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
FRS CIVILIAN PERSONNEL COST	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
FRS CONTRACT PERSONNEL COST	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
** SUBTOTAL FRS PERSONNEL	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
FRS TEMP. ADD. DUTY	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
FRS TRAIN. EXPEND. STORES	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
FRS MAINT. SUP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
FRS PERS. SUPP. SUP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
FRS POL	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
** SUBTOTAL FRS	.0	.0	.0	.0	.0	.0	.0	.0	.0	0

NALCOMIS-O+S/VAMOSC-AIR

NAVY AND MARINE CORPS AIRCRAFT COST REPORT BY T/M/S

VAMOSC-AIR-TSS FY 1976 ($ IN THOUSANDS; DATA AS LISTED) T/M/S: C-1?7D PAGE 4

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
OPERATIONAL TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
MAINTENANCE TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
** SUBTOTAL O/M TRAIN.	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
*** SUBTOTAL TRAIN. SUPP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	0

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
RECURRING INVESTMENT										
REPLACEMENT REPAIRABLES	50.2	19.9	6.3	16.4	.0	.9	.0	.0	.0	93
MODIFICATIONS	1.3	.7	.1	.4	.0	.0	.0	.0	.0	2
*** SUBTOTAL RECUR INVEST.	51.5	20.6	6.5	16.8	.0	1.0	.0	.0	.0	96

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	NAVEUR	MISC	TOTAL
OTHER FUNCTIONS										
NETS	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
CETS	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
PUBLICATIONS	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
*** SUBTOTAL OTHER FUNCTIONS	.0	.0	.0	.0	.0	.0	.0	.0	.0	0

NALCOMIS-O+S/VAMOSC-AIR

NAVY AND MARINE CORPS AIRCRAFT COST REPORT BY T/M/S

VAMOSC-AIF-TSS FY 1976 ($ IN THOUSANDS; DATA AS LISTED) T/M/S: C-117D PAGE 5

	PACFLT	LANTFLT	NET	MARINE	RESERVE	NAVAIR	OPNAV	HAVEUR	MISC	TOTAL
SUMMARY OF T/M/S										
ORGANIZATIONAL	21,253.7	14,408.4	121.4	1,048.7	.0	11.2	.0	.0	11.7	36,855
INTERMEDIATE	683.3	731.1	8.1	117.4	.0	4.9	.0	.0	.0	1,545
DEPOT SUPPORT	1,210.5	480.5	153.6	395.5	.0	24.0	.0	.0	.0	2,264
TRAINING SUPPORT	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
RECURRING INVESTMENT	51.5	20.6	6.5	16.8	.0	1.0	.0	.0	.0	95
OTHER FUNCTIONS	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
*** OVERALL TOTALS	23,199.2	15,640.7	289.8	1,578.6	.0	41.3	.0	.0	11.7	40,761

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APPENDIX F: TOP LEVEL MS FY 76 OUTPUT SUMMARY FOR C-117D AIRCRAFT

AIRCRAFT = C-117D

TOTAL COMPONENT MAINTENANCE COSTS(IN THOUSANDS OF $)

ORG.LEVEL LABOR RATE = 16.60 PER HOUR

INT.LEVEL LABOR RATE = 16.60 PER HOUR

ALL-NAVY SQUADRONS JULY 75 - JUNE 76

WORK UNIT CODE	ORGANIZATION MAINTENANCE LABOR SCH						INTERMEDIATE MAINTENANCE LABOR SCH							DEPOT COMPONENT REPAIR NARF D-LAB						TDC LABOR	WUC TOTAL COST
	LABOR SCH	LABOR UNSCH	CONSUM SCH	CONSUM UNSCH	SUPPT LABOR	TDC LABOR	LABOR SCH	LABOR UNSCH	CONSUM SCH	CONSUM UNSCH	SUPPT LABOR	TDC LABOR	ATTR	NARF D-LAB	NARF I-LAB	NARF MAT	COMMERC LABOR	COMMERC MAT	SURV		
03	484	0	0	0	49	0	7	0	0	0	3	0	0	0	0	0	0	0	0	0	541
11	37	36	36	14	28	0	3	6	0	0	10	0	0	0	0	0	0	0	0	0	170
12	3	7	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
13	19	65	9	20	21	0	6	22	8	27	30	0	8	4	6	7	4	1	3	0	258
14	17	24	0	0	11	6	3	5	0	0	12	0	6	1	2	0	0	0	0	0	88
21	60	153	32	20	26	2	1	10	1	5	35	0	0	8	13	16	18	3	5	0	408
29	35	65	46	31	24	0	9	8	0	0	62	0	1	3	5	2	30	6	2	0	328
32	16	35	0	0	11	0	7	19	0	2	50	1	0	2	5	1	26	5	0	0	183
41	7	21	0	0	7	0	0	2	0	0	7	0	0	1	2	1	9	1	0	0	59
42	23	64	18	23	15	1	37	46	2	2	5	0	11	6	8	9	0	0	1	0	269
44	2	8	2	6	5	0	0	2	0	[illegible]	0	0	0	0	0	0	0	0	0	0	26
45	9	24	5	9	9	0	1	6	0	[illegible]	10	0	0	9	12	8	0	0	1	0	104
46	3	12	1	2	3	0	0	1	0	0	3	0	0	1	3	5	0	0	1	0	37
47	1	2	0	0	1	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	13
49	1	3	0	0	2	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	12
51	6	63	4	10	10	0	0	9	0	0	3	0	0	11	18	4	1	0	1	0	142
52	0	11	0	0	2	0	0	3	0	0	0	0	0	2	4	1	0	0	2	0	26
61	2	9	1	1	1	0	4	15	0	0	1	0	0	9	15	2	0	0	2	0	62
62	4	18	0	0	3	0	1	22	0	0	1	0	2	6	9	2	0	0	1	0	70
63	2	21	0	3	5	0	7	108	1	8	3	0	0	17	27	9	0	0	4	0	216
64	2	18	5	14	3	0	2	7	0	1	0	0	0	1	2	1	0	0	1	0	58
65	0	11	0	0	1	0	1	6	0	0	1	0	0	1	1	0	0	0	0	0	23
66	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	7	78	1	1	13	0	11	117	2	22	4	0	3	16	22	4	0	0	16	0	317
72	0	4	0	0	1	0	0	5	0	0	0	0	0	2	3	0	0	0	0	0	15
91	1	1	2	2	1	0	0	1	0	0	16	0	18	0	0	0	0	0	1	0	43
96	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4
97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	742	753	161	157	255	9	101	421	14	69	268	2	52	102	158	76	88	17	42	0	3488

PRE-EX MAT	369
ORG SUPPT LAB	415
ORG TDC MAT	0
INT TDC MAT	0
DEP TDC MAT	0
GRAND TOTAL FOR C-117D	4272